STUDIES ON THE SEAWEEDS OF ANDAMAN AND NICOBAR GROUP OF ISLANDS

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JUNE - 1994

TO MY GRAND MOTHER

DECLARATION

I hereby declared that this thesis entitled "STUDIES ON THE SEAWEEDS OF ANDAMAN AND NICOBAR GROUP OF ISLANDS" is a record of original and bonafied research carried out by me under the supervision and guidance of Dr. V.S. KRISHNAMURTHY CHENNUBHOTLA, Principal Scientist, Central Marine Fisheries Research Institute, Cochin and that no part thereof has been presented before for any other degree in any University.

(B. MUTHU VELAN)

C E R T I F I C A T E

This is to certify that the thesis entitled "STUDIES ON THE SEAWEEDS OF ANDAMAN AND NICOBAR GROUP OF ISLANDS" embodies the research of original work conducted by Mr. B. MUTHU VELAN under my supervision and guidance. I further certify that no part of this thesis has previously formed the basis of the award of any degree, diploma, associateship, fellowship or other similar titles or recognition.

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1. INTRODUCTION

The importance of marine algae, often referred to as seaweeds, has been felt over a long time and is appreciated more and more in modern times. The economic value of marine algae is understood both indirectly and directly. The indirect benefit is due to the role of marine phytoplankton as well as the benthic macrophyte biomass along the shore and in the continental shelf, in primary production of the sea. Direct benefit includes the use of marine algae as food, feed, fertilizer and as source of various products of commercial importance such as agar and alginic acid.

Along the coastal line of India, the littoral and sublittoral rocky area support the good growth of different seaweeds (agarophytes, alginophytes and other seaweeds). There is a luxuriant growth of seaweeds along the south east coast of India, Gujarat coast, Lakshadweep Island and the Andaman and Nicobar group of islands. Fairly rich seaweed beds are present in the vicinity of Bombay, Rathnagiri, Goa, Karwar, Varkala, Kovalam, Vizhinjam, Visakhapatnam and few other places such as Chilka and Pulicat lakes, (Chennubhotla *et al*., 1987).

Today there is a greater awareness in many countries to cultivate the seaweeds in large scale to meet the demand for food and industry. In recent years many industries which are producing agar and algin from the seaweeds have come up in our country. Owing to the limited natural resources and increasing demand for them, it has now become necessary for us to cultivate them on large scale.

The assessment of available seaweed resources in India has been necessitated by more and more algin and agar industries coming up in recent years. Survey of the seaweed resources on the coastal area of Tamil Nadu, Maharastra, Gujarat, Lakshadweep and Andhrapradesh has been done recently (Krishnamurthy, 1985).

Except for the stray records of marine algae by different authors, Hills (1959), Srinivasan (1965, 1969, 1973), Taylor (1966) very little is known of the marine algae of the Andaman and Nicobar group of islands.

No detailed survey of seaweed resources except for a few preliminary investigations, more pertinent to quality only are available from Andaman and Nicobar group of islands. No report is available on the resource potential of agar yielding algae (agarophytes) and algin yielding algae (alginophytes) from these islands.

No information is available on the density, abundance, distribution pattern and duration of uninterrupted yield of these commercially important resources in these islands. Information is totally lacking on the interrelationship of environmental parameter on these resources.

Hence to understand the potential resources of seaweeds, their distribution, density, standing crop and interrelated environmental parameters, a detailed study (survey and ecological work) was carried out for a period of 20 months from August 1988 to March 1990 in South Andaman, North Andaman, Middle Andaman, Havelock, Neil, Car Nicobar, Terassa, Chowra and Bumpoka islands. However in South Andaman, data were collected from five fixed stations fortnightly during this period for the purpose of modelling and system analysis.

From these data, estimation of economically important seaweed resources of these islands were carried out in detail. Seasonal variation in distribution and abundance of seaweed species have been studied. Environmental factors such as rain, relative humidity, atmospheric temperature and water temperature, tide, wave, light, dissolved oxygen, salinity and chemical parameter such as nitrate, nitrite, phosphate, silicate dissolved in water influencing the occurrence and distribution of these resources were studied in detail.

Computer modelling is having profound effect on scientific research. Many scientific phenomenon are now investigated by complex computer models. (Jerome Sacks et al., 1989)

A model is a formulation that mimics real world phenomenon, and by means of which predictions can be made. In simplest form, models may be verbal or graphic ie. (informal). Ultimately, however models must be statistical and mathematical (ie. Formal) if quantitative predictions are to be reasonably good (Odum, 1971).

The application of system analysis procedures to ecology has come to be known as system ecology. In ecology, many of the modern conceptual models are inherently complex and difficult. Mathematical modelling may prove to be useful in several ways.

Based on the models described by Lassiter and Hayne (1971), Seip et al. (1979) and Seip (1980) a new model has been developed to carry on the following objectives with the help of FORTRAN V language.

Objectives

1. The species that grow at a particular place to form a community, their abundance, density and coverage in different seasons.

2. Dispersal of different species in space in different seasons.

3. Identification and observation of seral and climax communities and economically important species in different seasons to know the availability and position of these species in different seasons.

4. The identification of seaweed species which have strongest control over energy flow and the environment in the form of ecological dominance.

5. Finding out the important value indices with the help of relative frequency, relative density and relative coverage to understand the overall picture of the community structure and also to draw phytographs with the help of polygraphic methods to show the sociological characters of seaweed species in different seasons.

6. To study the total diversity of seaweed species, diversity of seral and climax communities in different seasons and diversity of economically important seaweed groups in different seasons.

7. To make possible comparison of the different systems to see the similarity between them in different seasons.

8. Study of interrelationship and effects of environmental parameters in the seaweed ecosystem and

9. To explore the possibility of seaweed mariculture in this area.

2. REVIEW OF LITERATURE

2.1 SURVEY

A wealth of information has been published on the marine algae of the Indian coasts. Yet, we cannot claim to have sufficiently covered the entire coast to be in a position to compile a comprehensive report on the marine algal flora of this region. Our current knowledge of the Indian marine algae stems from the publication of Boergesen (1933a, 1933b, 1934a, 1934b, 1935, 1937a, 1937b, 1938) who carried out the pioneering work on the marine algae of South India, Bombay and Gujarat coasts. However, there are available in literature various records of the Indian marine algae dating back to even Pre-Linnear year. Except for stray records of marine algae by different authors, Hills (1959), Srinivasan (1965, 1969, 1973) Taylor (1966), very little is known of the marine algae of the Andaman and Nicobar group of islands. Krishnamurthy (1985) covered most of the islands in Andamans for the project on the marine algal flora of India.

Jagtap (1983) surveyed the marine algae, in his studies on littoral flora of Andaman islands, among these 26 species were coming under Rhodophyta, 21 species under Chlorophyta and 14 under Phaeophyta.

A review of the seaweed resources of the world has been made by Michanek (1975). Some information is available on the seaweed resources of Indian waters such as Chilka lake (Mitra, 1946), certain areas of Tamil Nadu (Chacko and Malu Pillai, 1958; Thivy, 1960; Varma and Krishna Rao, 1962; Desai, 1967; Umamaheswara Rao, 1972 a, 1973; Kannan and Krishnamurthy, 1978 and Subbaramaiah _et al_., 1979a), Kerala Coast (Koshy and John, 1948) Gujarat coast (Sreenivasa Rao _et al_., 1964; Desai, 1967; Chauhan and Krishnamurthy, 1968; Bhanderi and Trivedi, 1975; Chauhan and Mairh, 1978 and Ragothaman, 1979), Maharashtra Coast (Chauhan, 1978 and Untawale _et al_., 1979), Goa Coast (Untawale and Dhargalkar, 1975), Andra Pradesh Coast (Umamaheshwara Rao, 1978) and Lakshadweep (Subbaramaiah _et al_., 1979b).

A detailed survey of red algae were conducted by Desai (1967) in the Gulf of Mannar in ten miles area North and South of Kilakarai. The estimates of dry _Gelidium_ and _Gracilaria_ were 300 and 3000 tonnes per annum respectively.

Thivy (1964) reported that the total Indian algin potential to be 500 metric tonnes (refined) annually and the agar potential to be 13 metric tonnes (Bacteriological grade) annually, based on the possible yield of 19% (range 7-30%) of algin and 28% (range 12-43%) of agar by dry weight.

Sample surveys were conducted by Umamaheshwara Rao (1973) in a 3.58 Sq.Km. area between Pamban bridge and Theedai during the calm seasons of 1965 and 1966. The quantitative data obtained on the standing crop of different seaweeds were mentioned as follows in fresh weight in metric tonnes, agarophytes 233.15 (1965) and 47.92 (1966), alginophytes 161.83 (1965), and 173.43 (1966), edible algae 188.84 (1964), and 245.91 (1966) and other algae 457.87 (1965) and 398.51 (1966). Except in agarophytes there was no significant variation in the standing crop of different types of seaweeds.

The survey conducted along Gujarat coast by Sreenivasa Rao *et al.* (1964) estimated fresh *Sargassum* at 60 metric tonnes in 0.015 sq.km. area of the Adatra reef near Okha. Central Salt and Marine Chemical Research Institute estimated the resources of the agarophytes along Gujarat coast as 12 tonnes (fresh weight). In the Gulf of Kutch 10,000 tonnes of brown algae by dry weight, 5 tonnes of wet *Gelidiella* and 20 tonnes of *Gracilaria* by dry weight could be harvested (Desai, 1967).

Chauhan and Krishnamurthy (1968) surveyed Dera, Goos, Narara, Sika, Karumbhar and Baide areas of Gulf of Kutch and estimated the fresh seaweeds at 18765.5 metric tonnes in 10.65 sq.km. of coastal water. In this, *Sargassum* spp. formed 120105.00 tonnes of which about 4000 metric tonnes were harvestable each year.

The survey of seaweed from Okha to Mahuva in Saurastra coast was carried out jointly by the Central Salt and Marine Chemical Research Institute and Department of Fisheries, Government of Gujarat (Chauhan and Mairh, 1978). The brown seaweed Sargassum constituted three-fourth of the algal biomass. It was followed by the green alga Ulva. Gracilaria and Gelidiella were forming minor quantities.

Bhanderi and Raval (1975) conducted surveys on the tidal region of Okha-Dwarka coastline and estimated fresh Sargassum at 1000 metric tonnes. According to their assessment , about one ton of fresh Gelidiella and 10 tonnes of fresh Gracilaria could be harvested from the coastline. These findings coincide with that of Central Salt and Marine Chemical Research Institute, Bhavanagar.

The seaweed resources of Andra Pradesh were dealt with in detail by Umamaheswara Rao (1978). In general agarophytic resources were less while Sargassum species were more abundant in different localities of the coastline.

Central Marine Fisheries Research Institute of India carried out for 5 years survey of marine algae resources along Tamil Nadu coast (1971-1976) in collaboration with Central Salt and Marine Chemical Research Institute and Department of Fisheries, Government of Tamil Nadu (Subbaramaiah _et al_., 1979 a). The area covered was from Athankarai to Rameshwaram in the Palk Bay (45 km distance) and from Mandapam to Colachel, Kanyakumari district (413 km distance) and the adjoining islands in the Gulf of Mannar to a depth of 4m. The standing crop in the coastal area of 17125 hectares was estimated at 22044 tonnes, consisting of 1709 tonnes of agarophytes, 10266 tonnes of alginophytes and 10069 tonnes of other seaweeds.

The seaweed resources survey of the Goa coast was conducted by Untawale and Dhargalkar (1975). The total standing crop of the coast from Dona Paula to Chapora (0.150 sq.km. area) was about 256.6 metric tonnes fresh weight per year.

Subbaramaiah _et al_. (1979 b) studied the marine algal resources of Lakshadweep. Among the 9 islands surveyed, Kavaratti, Agathi, Kadamat, Chetlat, Kiltan, Androth and Kalpeni supported marine algal growth while Bengaram was barren. Out of the total area of 2555 hectares surveyed, 785 hectares were found to be productive. Total standing crop of the marine algae estimated was 3645-7598 tonnes (wet weight). The groupwise biomass and their percentage of standing crop of the population were agarophytes 961-2074 tonnes (27%), alginiophytes 9-15 tonnes (0.2%) and other algae 2675-5509 tonnes (72.8%).

The marine algal resources of Maharashtra coast was surveyed by Chauhan (1978). The total harvestable standing crop estimated were Sargassum 238.417 to 310.097 metric tonnes fresh weight and Ulva 3.483 to 4.516 metric tonnes fresh weight.

2.2 ECOLOGICAL STUDY

Ecological studies have been carried out on the marine algal vegetation of the Mahabalipuram coast (Srinivasan, 1946), Chilka lake (Parija and Parija, 1946), Saltmarshes at Madras (Krishnamurthy, 1954). The colonization of marine algae on a fresh substratum was studied by Varma (1959) by suspending a concrete block in the Palk Bay and data were collected on settlement of spores and further development in several algal species.

Ecological studies had been carried out on the marine algal vegetation of Okha, Porebandar, Veraval and Bombay areas (Misra, 1959), Vishakhapatnam Coast (Umamaheswara Rao and Sreeramulu, 1964). Krishnamurthy (1967) postulated a new set of principles governing zonation of marine algae on the Indian coasts and reported that marine algae in these coasts were essentially subtidal and many form a subtidal fringe at the lower intertidal. Recolonization of studies were also made by Umamaheswara Rao and Sreeramulu (1968) on Vishakhapatnam coast by clearing areas of $0.5m^2$ in the Gracilaria corticata belt. The sequence of colonization was followed for a period of five months. Ulva and Enteromorpha were seen as first colonizers and fresh germlings of Gracilaria corticata reappeared in the denuded areas after a few months. Marine algal studies of Okha area have been conducted by Gopalakrishnan (1970).

The role of critical tide factor in the vertical distribution of Hypnea musciformis was studied by Rama Rao (1972). Umamaheswara Rao (1972 c) made observations on zonation and seasonal changes of some intertidal algae growing in the Gulf of Mannar and Palk Bay for a period of two and a half years and the data were given together with the changes observed in the tidal behaviour and other environmental conditions. The relationship between the variations in the periods of submergence and emergence caused by tides and seasonal changes in the algal growth were reported, in addition to the influence of local environmental conditions on the growth cycles of algae to a large extent. Certain variations were noticed in the maximum growth periods of Enteromorpha and Sargassum in the Gulf of Mannar and Palk Bay.

The distribution pattern of marine algae on the shore of Pamban was studied by Subbaramaiah *et al*. (1977), Krishnamurthy and Balasundaram (1990) on Tiruchendur Coast, Balakrishnan Nair *et al*. (1990) on Kerala Coast and Rajendran *et al*. (1991) on Northern part of the Tamil Nadu Coast.

2.3 MODEL

According to Krebs (1972) an attempt should be made to drive unifying ideas in terms of models and axioms from the vast body of biological knowledge presently available. He defined the concept of a model as a simplified system which represents some of the essential features of reality and which provides explanations of experimental observations and insights which are starting points for a full exploration of reality. In principle, the building of model or working on hypothesis is one and the same, as each attempt to derive from nature some significant aspects of each.

Kalmax (1968) held that a model is the summary of experimental data and accordingly should yield the same experimental data that were used in its constructions.

Since modelling refers to determination of a quantitative picture of the important system characteristics, Van Dyne (1966) considered modelling as mathematical abstraction of real world situations which are thus subjected to mathematical arguments in order to derive mathematical conclusions.

The parameters used in model constructions should be truely representative and confirm the properties of real world situation. Beck (1981) explained that variations and values backed by strong logical arguments only can help to match the structure of the model, and also helped to understand the observed pattern of behaviour. The strength of a model, therefore, lies in its mathematical arguments arising out of which are the theorems and their interpretations worthy of giving new insight into the real world. Thus model built on the true properties of the real world allows an empirical determination of the best operating conditions in the system.

According to Odum (1971), a model is a formulation that mimics real world phenomenon and by means of which prediction can be made. In simplest form models may be verbal or graphical (ie. informal). Ultimately however, models must be statistical and mathematical (ie. formal) if quantitative prediction ought to be reasonably good.

Lassiter and Hayne (1971) considered that models are obstructions of a real world phenomenon. They used frame concepts and organised knowledge to the end that the right questions may be asked. Some models are mathematical, they do not differ in any basic way from non-mathematical models. They are expressed in formal notation, tend to be more explicit and proceed in natural sequence from the conceptual to the quantative form.

A model on the behaviour of a compartment (or reservoir) including any part of nature which have clearly defined boundaries and which encompasses a group of objects of similar nature is called compartment (also box) model (Erikson, 1971). He also opined that the model of averaged properties in defined spaces may be integrated to have a detailed view of the process in that space. The first model of this type was reported by Erikson and Welandor (1956) for carbon circulation and by Craige (1957) for carbon circulation in a nature. They attempted to quantify the relations between amounts and fluxes of properties in such compartmental model system.

Differential equations have been most used in the development of ecological models and computers have been employed (Garfinkel, 1962, 1967; Garfinkel and Sack, 1964; Pattern, 1965; Wangersky and Gunningham, 1957b; King and Paulik, 1967. The characteristics of the method have been discussed in detail by Watt (1966, 1968).

A model described by Lassiter and Hayne (1971) has been used as a base model for this study. But since this study is totally concentrating on the population parameters like frequency, density, coverage, abundance, population size, distribution and dominance and for community level diversity and similarity, it has subsequently been modified and developed during this work.

A mathematical model developed by Seip et al. (1979) to study the distribution and abundance of benthic algae species in a Norwegian fjord and a model constructed by Seip (1980) to study the competition and colonization in a community of marine benthic algae on the rocky shores of a Norwegian fjord were also refined for this study.

In ecology many of the modern conceptual models are inherently complex and difficult. Mathematical modelling may prove to be useful in several ways. First, it provides a means of systematic organisation which hitherto has been ignored. If a model can be adequately quantified, then a test of the validity of general ideas may be possible. System analysis provides the basic ideas that may make possible the attack upon so complex an entity as an ecosystem. This is that the whole complex can be studied by modelling in separate parts and then combining these sub-systems into the whole. (Lassiter and Hayne 1971).

2.4 THE SYSTEM

A system is a part of reality that contain interrelated elements (De wit and Rabbinge, 1979) of various specifications, some of which have close links with observed behaviour, and therefore a system ought to be most useful in giving insight into true biological mechanism (Mesarovic, 1968). In the light of Mesarovic's thinking that the behaviour of a system is input-dependent i.e. its input-output relation depends upon the type of stimulus and amplitude. Interestingly the operational definition advanced by Watt (1968) holds promise. He viewed the system as being an interlocking complex of processes characterised by many reciprocal cause effect path ways. Further more, a system is not merely an interaction. Anokhin (1968), thought it also to be the integration of the activity of all its components in order to provide an effective response appropriate to the input at a given moment.

Ongoing system is repetitive in nature and can be recreated in a relatively short span of time. Modelling on these systems is simple and easy because these systems can always be utilized experimentally for verifying the validity of the constructed model. On the basis of life it can be classified into biotic system, comprising the seaweeds and the abiotic system which are considered here as forcing factors such as rain, relative humidity, wave, tide and depth which are known as common forcing factors and temperature, salinity, dissolved oxygen, nutrients are considered as specific forcing factors.

3. MATERIALS AND METHODS

3.1 MATERIALS

The Andaman and Nicobar islands enjoy the status of an archipelago with over 550 islands, islets and rocky outcrops with Bay of Bengal, lying between 6^{o} 45'N N and 13^{o} 41'N latitude and between 92^{o}12'E and 93^{o} 57'E longitude with a land area of only 8293 sq. km. It has a total coastal line of 1962 km which is about one fourth of the total coastal line of India (Fig.1) where the present studies were made in following islands at depth upto 5 metres from the coast and an extensive study on ecosystem modelling was carried out in South Andaman island.

3.1.1 South Andaman

In South Andaman the study area was between 11^{o}4'N latitude, 92^{o}46'E long to 11^{o}31'N latitude 92^{o}42'E long (Fig 2). The shore line is mingled with rocky and marshy substratum. Apart from the mangrove vegetation, the seaweeds also have dense population in this area. During the study period an area of around 40.10 sq km with a shore length of around 212 km were covered with fixation of 18 stations.

For the ecological modelling study totally 5 station were fixed and the sampling were made fortnightly. (Fig. 2a)

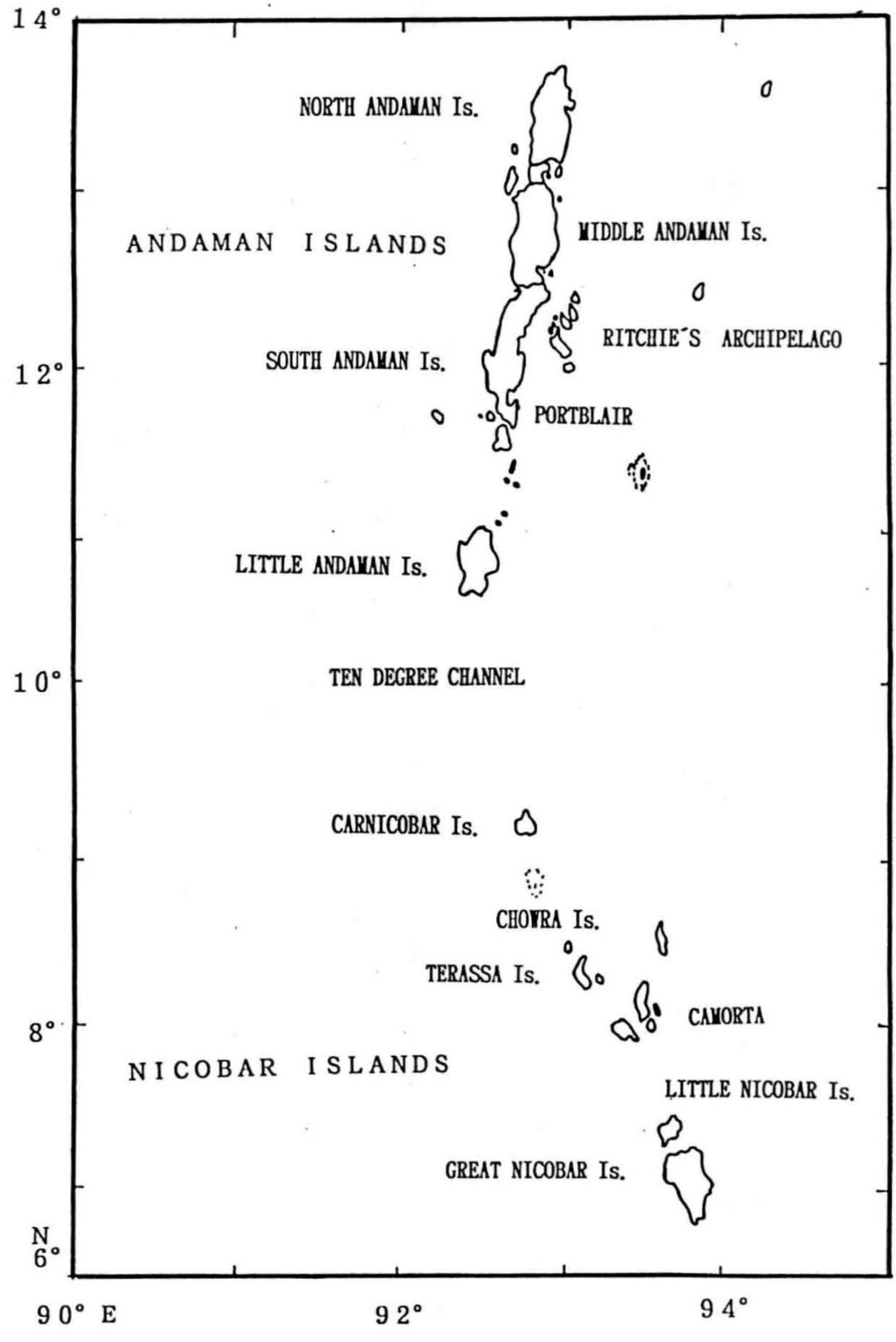


Fig.1. Andaman and Nicobar Islands.

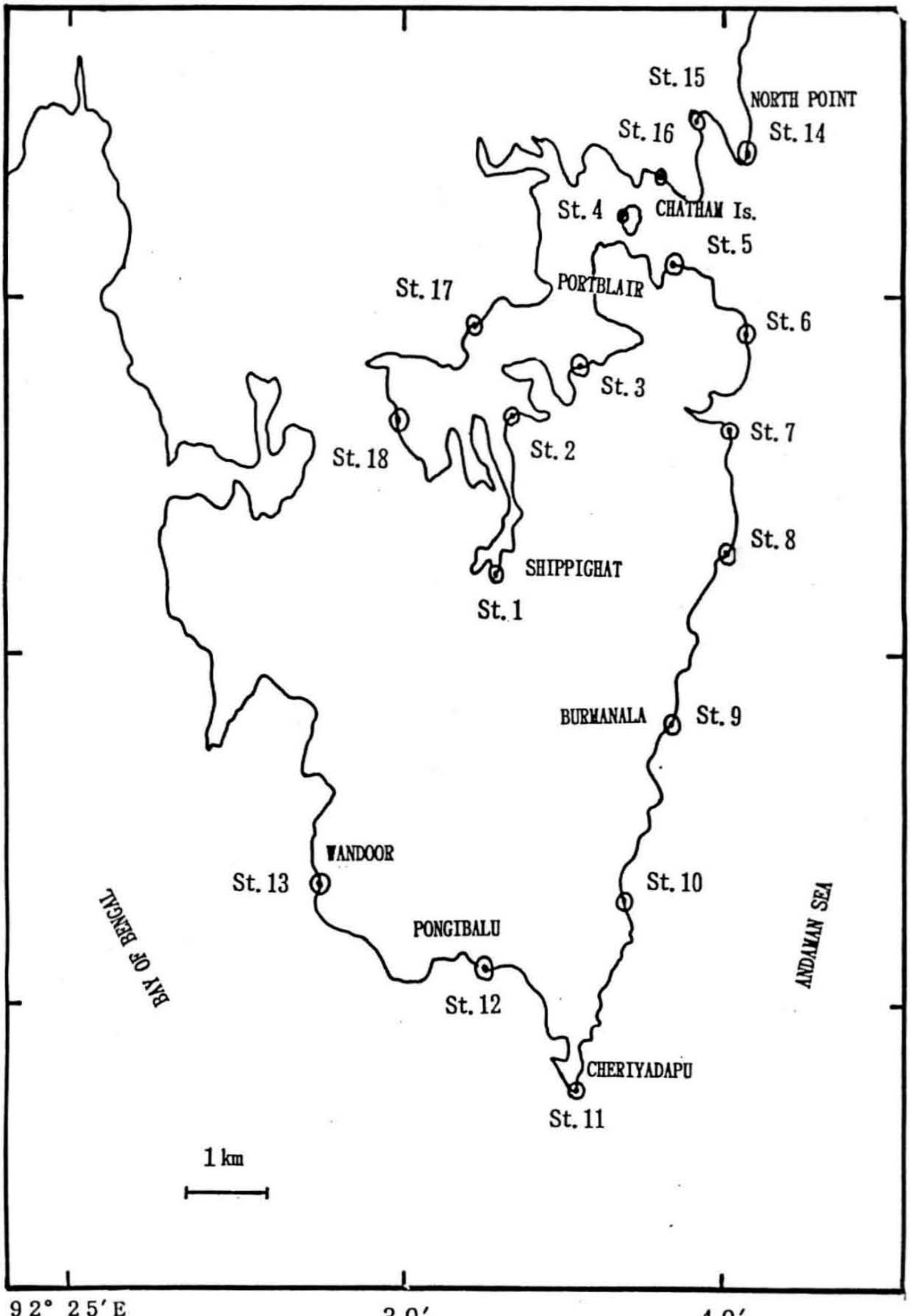


Fig. 2. The Study Area —South Andaman Is.

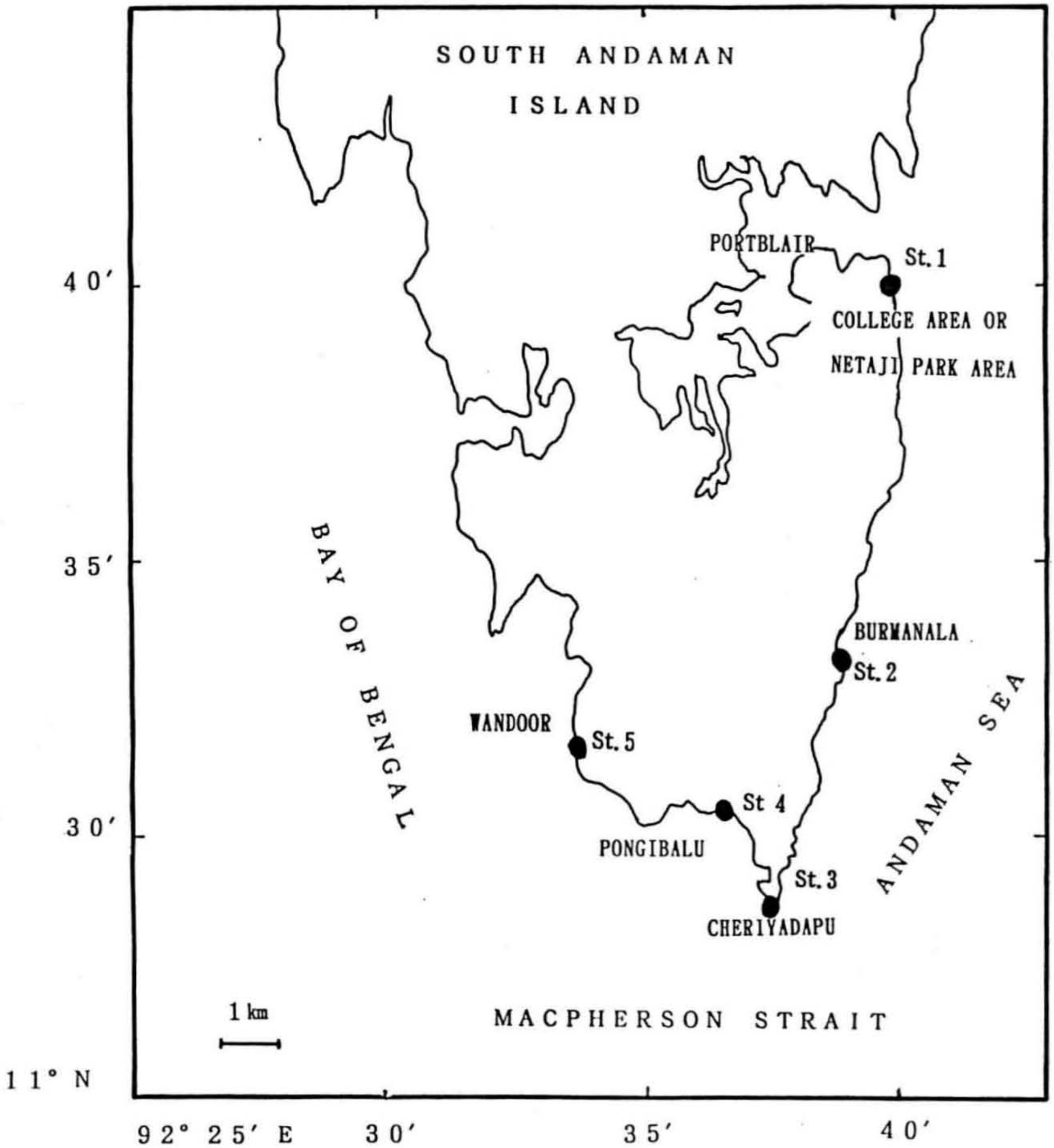


Fig. 2a. Five Fixed Sampling Area–Ecological Modelling Studies

3.1.2 **Mayabunder** : (Middle Andaman)

Mayabunder is situated in $12^{o}55'$N latitude, 92^{o} 54'E long with rocky terrain. The jetty area has limited sandy beach, otherwise the shore is muddy with luxuriant mangrove vegetation. There were dense growth of seaweeds in the subtidal part of the nearby islands. During the study period totally 17 stations were fixed (Fig. 3) for the survey. An area of around 22.4 sq. km. with a length of around 72.9 km. along the shoreline was covered.

3.1.3 **Digilipur (North Andaman)**

Digilipur which comes under North Andaman island is situated in $30^{o}16'$ to $17^{o}17'$N latitude and 93^{o} 7' to elevation of 76 m. The bay area is shallow, the Northern stretch and the Southern stretch are free of mangroves with dense algal vegetation. During the period of study totally 13 stations were fixed for the survey and an area of around 24.78 sq.km. were covered in which the shore line length was around 52.25 km. (Fig. 4)

3.1.4 **Neil:**

The island is situated in Ritchie's archipelago with $11^{o}49'$ to $11^{o}51'$N latitude and $93^{o}01'$ to $93^{o}04'$E. long. Shore line is covered with mangroves and seaweeds. The subtidal area shows dense algal growth. During the period of

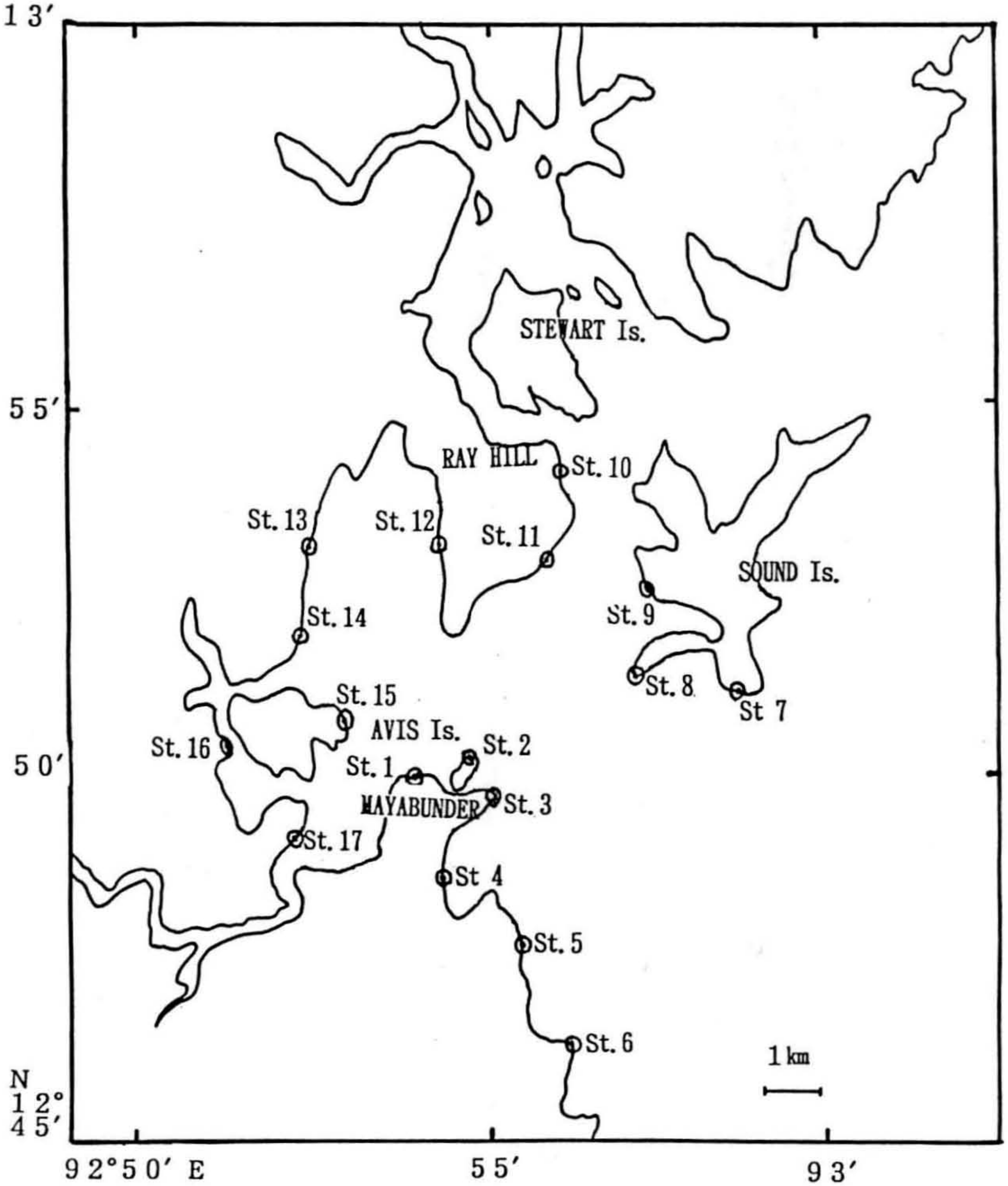


Fig. 3. The Study Area –Mayabunder, Middle Andaman Is.

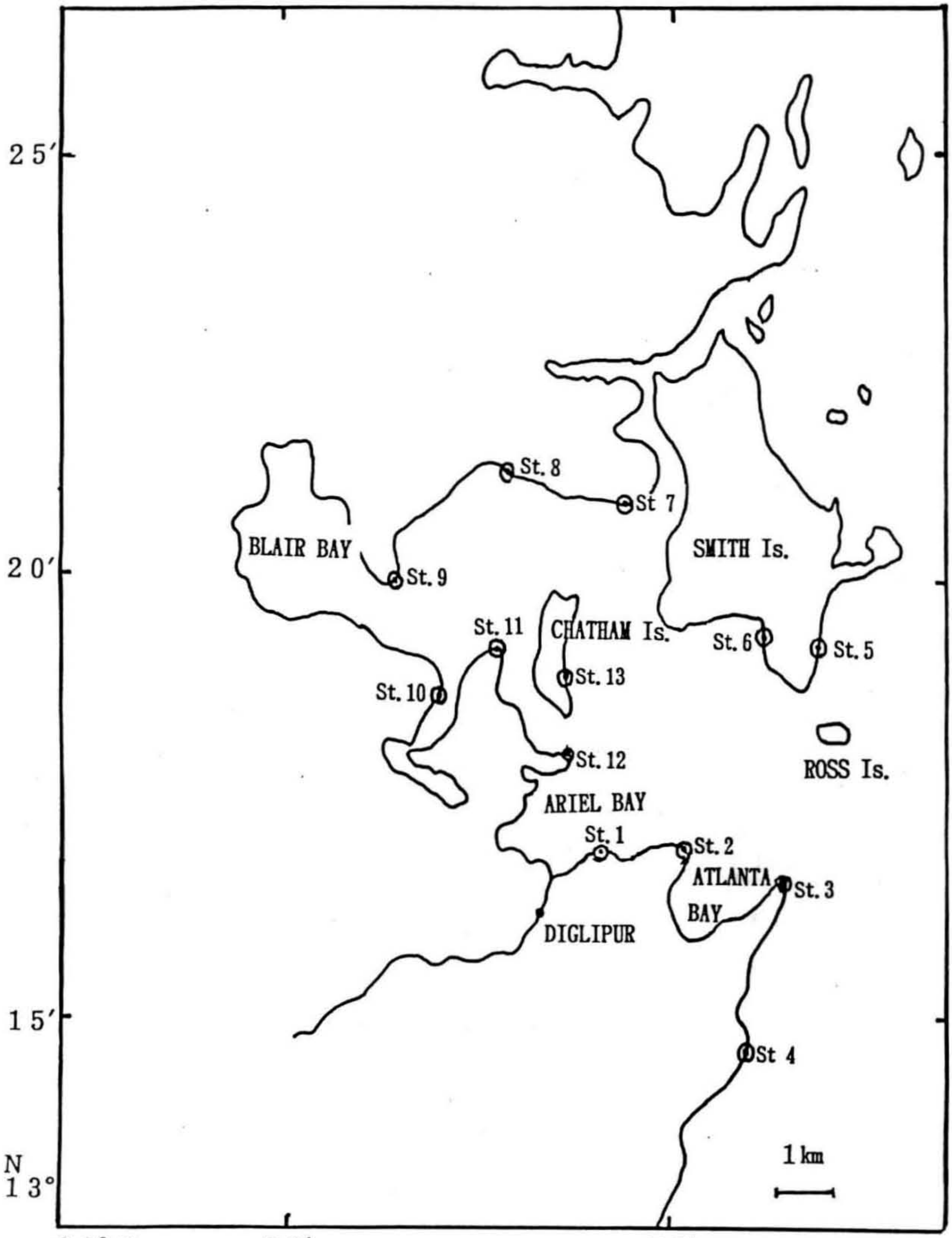


Fig. 4. The Study Area –Diglipur, North Andaman Islands.

survey the observation were made from 10 stations in an area of around 26.90 km (Fig 5).

3.1.5 Havelock

This also comes under Ritchie's archipelago between $11^{o}53$ to $12^{o}03'$N. latitude and $92^{o}55'$ to $93^{o}04'$E. long. It is one among the largest hilly islands nearly 65 sq.km. area, with maximum elevation of around 168m. Except Kalapathar creek, rest of the shore area witnessed dense algal vegetation. During the period of survey totally 13 stations were fixed for observation. The covered area was around 42.44 km. (Fig.5).

3.1.6 Car Nicobar

The island is situated in between $9^{o}8'$ to $9^{o}15'$N latitude and $93^{o}50'$E. long. It is terrain with maximum elevation of 73m. Most of the area of shore line has rocky substratum with vast intertidal area and devoid of mangrove vegetation. The seaweeds grow luxuriantly all along the intertidal area. The observations were made for 12 stations from an area of around 33.487 sq.km. (Fig.6).

3.1.7 Terassa

The island is situated in between $8^{o}05'$ to $8^{o}22'$N latitude and $93^{o}05'$ to $93^{o}12'$E long., which is also terrain

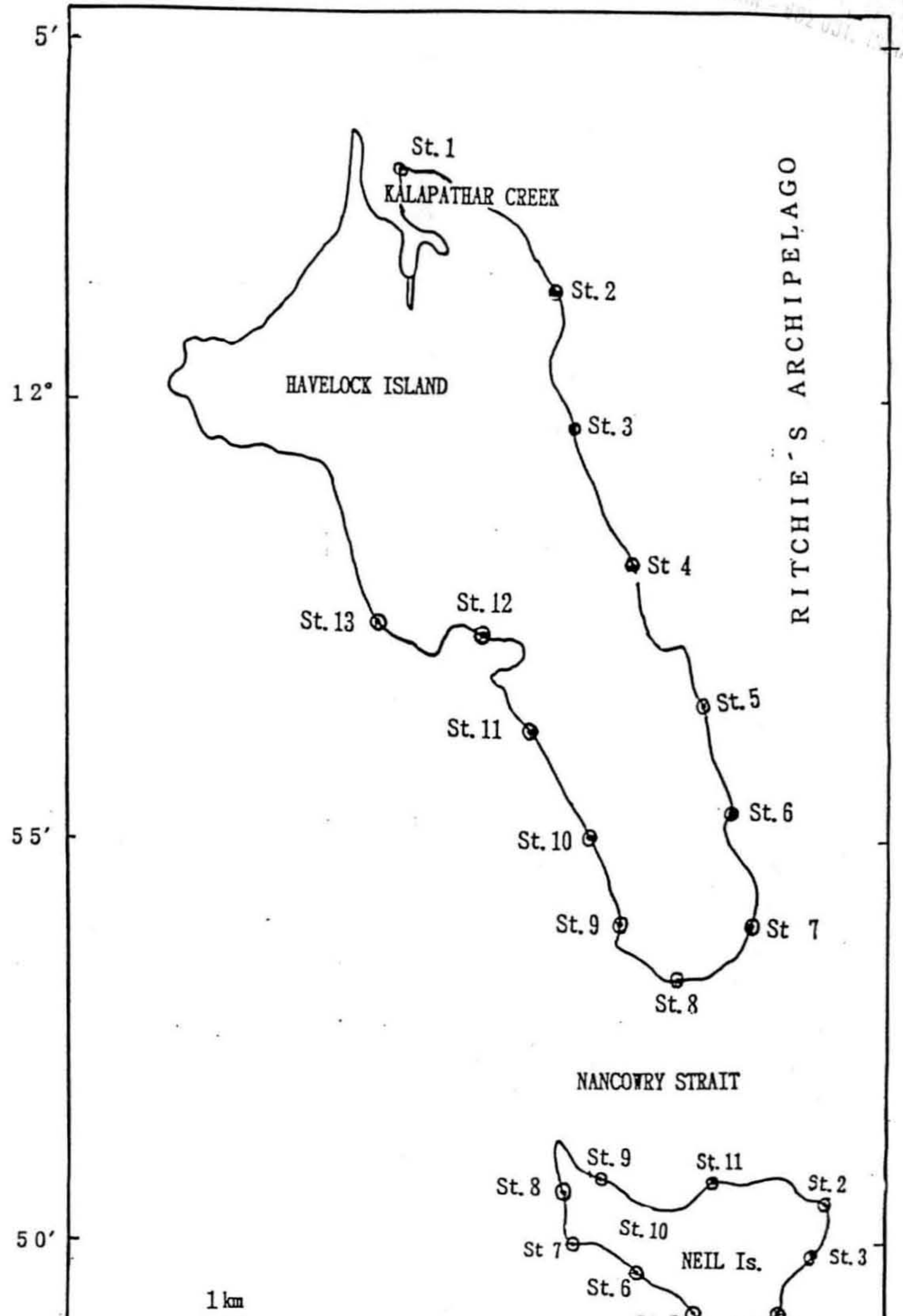


Fig.5. The Study Area -Neil And Havelock

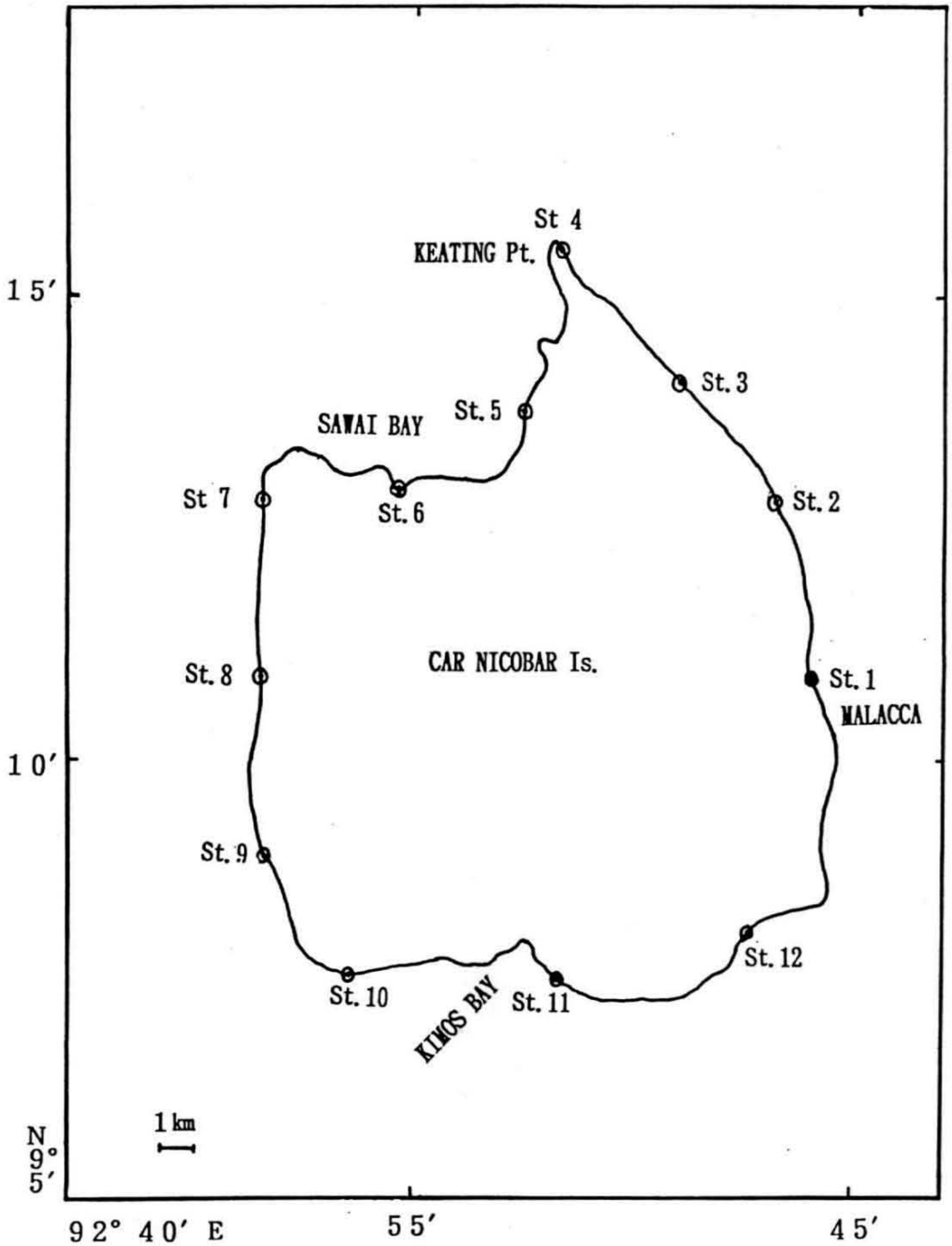


Fig. 6. The Study Area – Car Nicobar Island

in nature. The shore line has rocky substratum with broad intertidal area in most of the places. But the seaweed shows normal distribution even though the area is devoid of mangrove vegetation. An area of 60.03 sq.km. with 8 stations was studied during the survey (Fig.7).

3.1.8 Chowra

This island is situated in between $8^{o}27'$ to $8^{o}29'$N. latitude and $93^{o}03'$E. long. with terrain and hilly in the South Corner. The shore line is rocky and sandy in most of the area. Seasonal deposition of sand and erosion play major role in the algal distribution. An area of 9.91 sq.km. was studied and surveyed (Fig.7).

3.1.9 Bumpoka

The island is situated in between $8^{o}13'$ to $8^{o}16'$N. latitude; and 93^{o} 13' to $93^{o}15'$E. long. The intertidal area is entirely of rocky substratum. The seaweeds have dense vegetation in the Eastern part of the island. During the survey an area of 6.554 sq.km. with 4 stations was surveyed (Fig.7).

3.1.10 Computer Analysis

The data collected from these islands were analysed statistically with the help of WIPRO PC/XT Computer, programmed with Software in basic language and

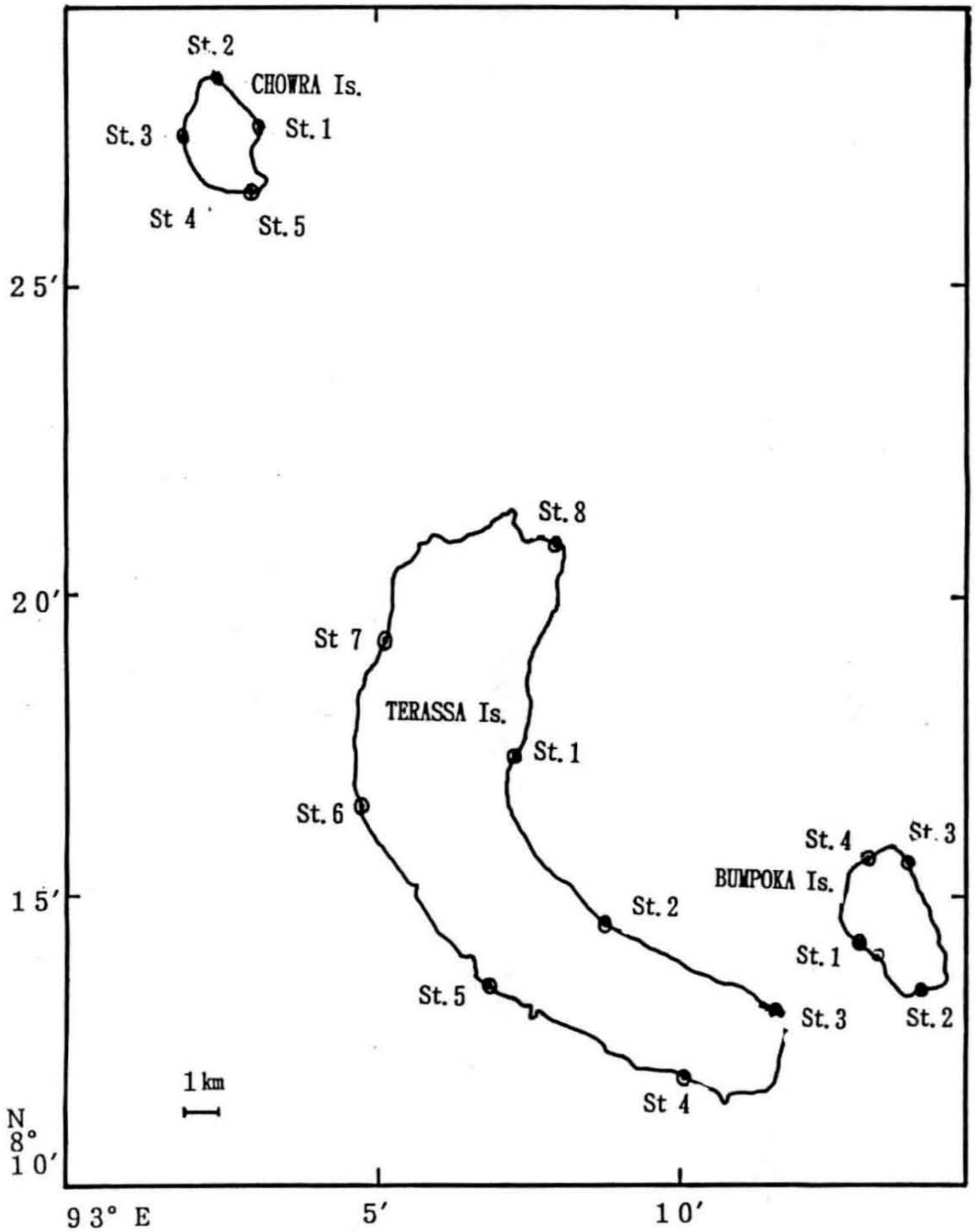


Fig. 7. The Study Area —Terassa, Chowra and Bumpoka Islands

used to estimate the density, standing crop and area calculations from the survey data of the above said 9 islands. For the ecological modelling and system analysis, a Software Package with SPSS with respect to the objectives mentioned above was applied and analysed. The hierarchical cluster analysis was made by dendrogram using average linkage method between seaweed species for the intertidal and subtidal parts of five systems.

3.2 METHODS

The survey comprised four steps.

1. Fixing of stations and area calculation.
2. Sampling.
3. Identification of species and
4. Biomass estimation.

3.2.1 Fixing of stations and area calculation:

The compass survey was adopted with prismatic compass and tape to orient the shore and to fix the station (Fig.8). The transect perpendicular to the shore through the station was called central transect at 100 metres apart at each station in both side which were called lateral transect, were fixed and the perpendicular offset with respect to the orientation of the line were constructed. With the help of hand level and level staff, the levels from the station and transects to water point were observed and with the help of tape the slope distance were recorded. From the water point to the various depths the subtended sangle were noted. From plotting the values of the range lines and transects corresponding angles intersecting points were indentified and measured. The corresponding depth corrected to the tide variation were computed to arrive at the relative depths. The length at each depth was taken as over the water surface and computed to the slope length with respect to mid depths. A check was also implemented to find out the slope length at mid depth.

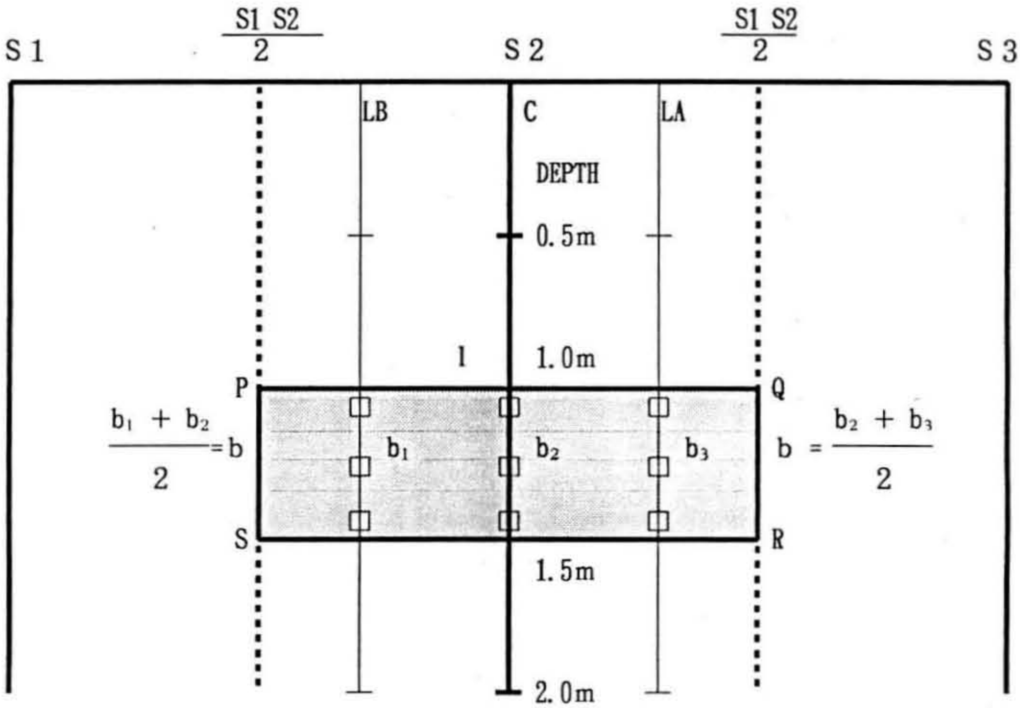
With the help of sextant the distance was calculated. To calculate the area, mid point from the station in both side were fixed and with the help of sextant the distance between two mid points were calculated and was called length. The breadth was calculated at the limit of the vegetation and it was calculated from rearranging the three (lateral, central and lateral) transects length in its respective vegetation limit. Then the area was calculated by multiplying the length and the breadth. (Fig 8)

3.2.2 Sampling

It has two steps.

(a) Sampling unit

FIGURE - 8
SURVEY METHOD



S 1, S 2, S 3 = Stations
C = Central Transect
LA = Lateral Transect A
LB = Lateral Transect B
l = Lenth
b = Breath
☐ = Quadrat

(b) Sampling method

(a) **Sampling unit**

Quadrat method was used as sampling unit in which three general consideration were involved in the choice of the size and shape for sampling units.

The first consideration was practically in linking plot boundaries and taking measurements. The most practical size however depended on the type of vegetation being measured. So a 0.25 sq. m (0.5 m x 0.5 m) quadrat was used for seaweed sampling.

The edge was also taken into consideration to avoid error.

The balance of effort between measuring a few large area or many small area were taken into consideration and was avoided by increasing or decreasing the number of sampling.

(b) **Sampling method**

Systematic and simple random sampling methods were used in all sampling programmes.

In systematic sampling only first unit was selected at random and the remaining got selected automatically, according to the predetermined pattern. Here, the area of 0, 0.5, 1, 1.5, upto 5 meters in depth in transects were predetermined for sampling along with simple random sampling in related area were also carried out.

3.2.3 **Identification of species** (Plate 2, 3, 4)

The available species in all nine islands were collected and their morphological characters were carefully analysed for species identification with the aid of pioneer reference on taxonomy of seaweeds published by various authors. (Bhanderi and Trivedi, 1975; Chennubhotla *et al.*, 1987; Gopinathan and Panigrahy, 1983; Jagtap, 1983; Krishnamurthy, 1985; Krishnamurthy and Balasundaram, 1990; Michanek, 1975; Subbaramaiah *et al.*, 1977, 1979; Umamaheshwara Rao, 1972a, 1973).

3.2.4 **Biomass estimation**

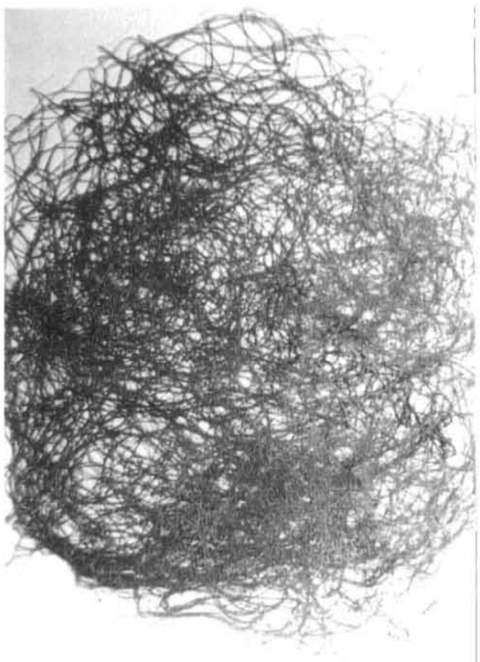
The seaweeds, inside the 0.25 sq.m quadrat in each sampling were subjected for individual biomass estimation (drained wet weight) after separating the species. Drained weight was measured from the seaweed samples collected from each quadrat and were recorded separately by using a Kitchen (Yamato) balance.

The population mean was considered as density in biomass per square metre. The population dispersion (Standard deviation) was taken as increased or decreased

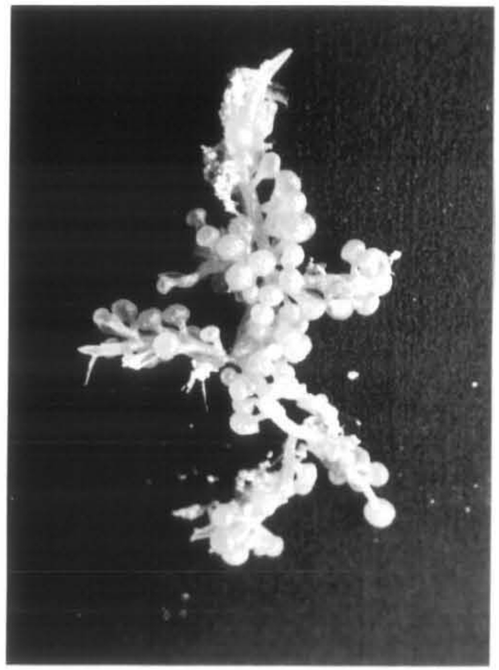
PLATE – 2

SOME OF THE CHLOROPHYCEAE MEMBERS

Order : CLADOPHORALES
Family : CLADOPHORACEAE
Species : *Chaetomorpha antennina*



SIPHONALES
CAULERPACEAE
Caulerpa racemosa



SIPHONALES
CODIACEAE
Halimeda tuna

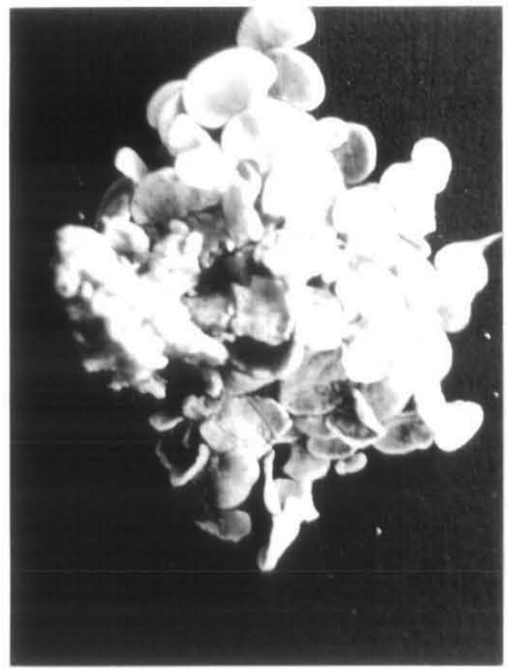
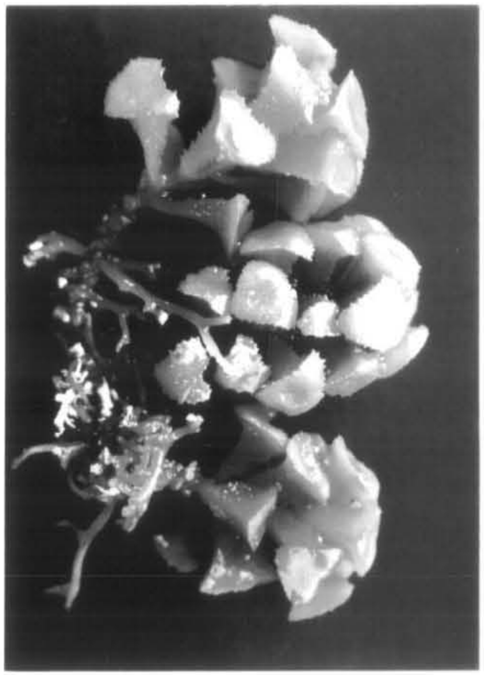


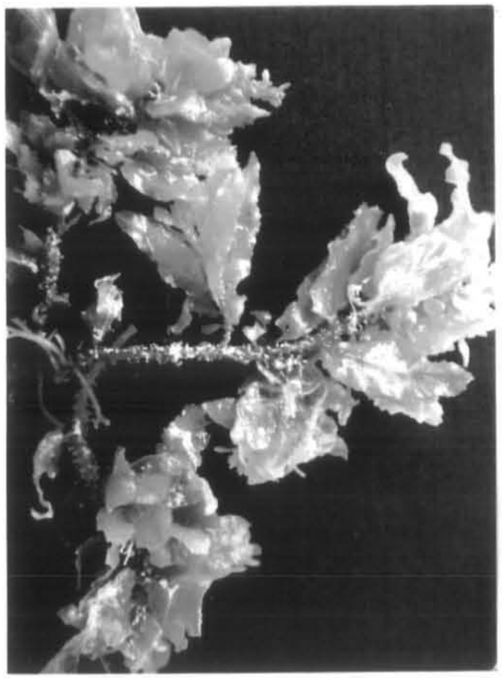
PLATE - 3

SOME OF THE PHAEOPHYCEAE MEMBERS

Order : FUCALES
Family : SARGASSACEACE
Species : *Turbinaria ornata*



FUCALES
SARGASSACEAE
Sargassum wightii



FUCALES
SARGASSACEAE
Sargassum ilicifolium

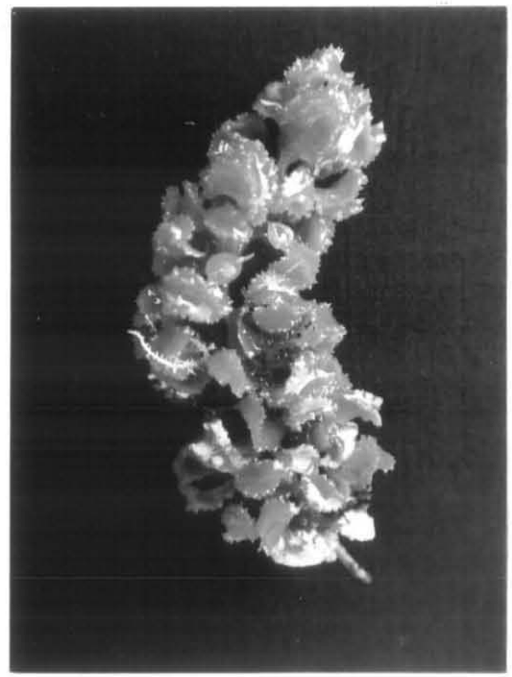
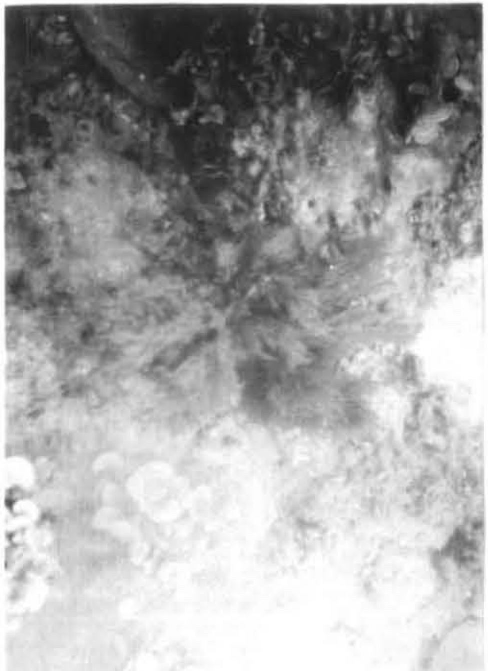


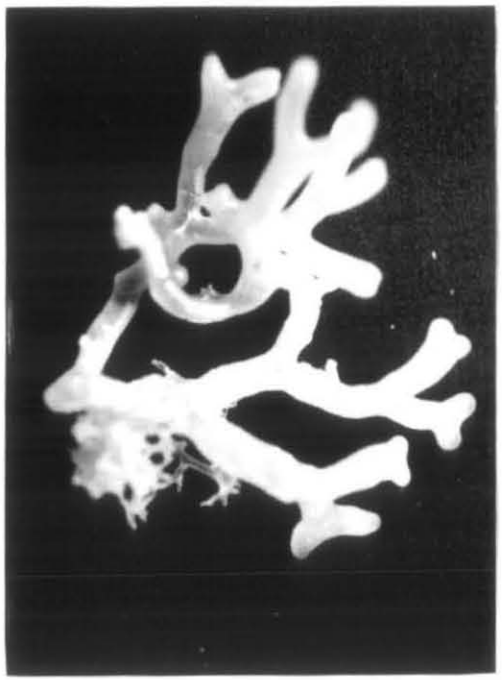
PLATE - 4

SOME OF THE RHODOPHYCEAE MEMBERS

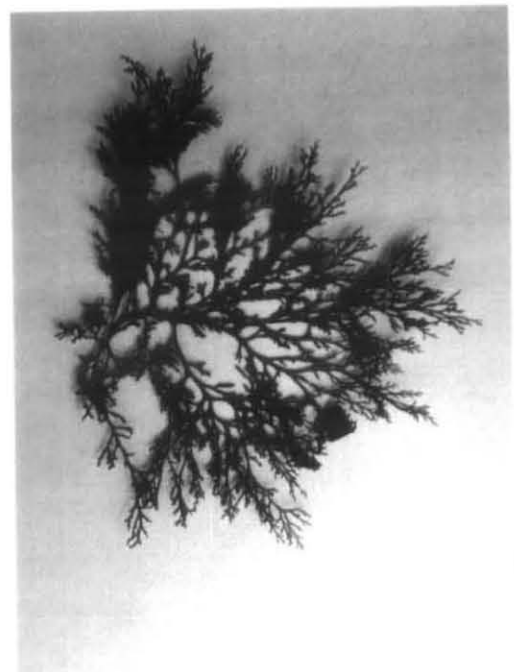
Order : CRYPTONEMIALES
Family : GRATELOUPIACEAE
Species : *Halymenia floresia*



GIGARTINALES
GRACILARIACEAE
Gracilaria crassa



CRYPTONEMIALES
RHIZOPHYLLIDACEAE
Chondrococcus hornemanii



quantity in density. These representative density value of each species per square metre was multiplied with the area and was taken as the biomass of the species and was expressed in Kg/ton.

3.3 ECOSYSTEM MODELLING

This study had three steps they were the following.

1. Collection of seaweed samples.
2. Hydrological study and
3. Collection of Meteorological data

3.3.1 Collection of seaweed samples

The seaweeds were collected by the above said quadrat method from the intertidal and subtidal parts of each station. (Hereafter it will be called as 5 systems) During each sampling period 10 quadrats study were made for each part (Intertidal and subtidal) in all systems. The collected seaweed species were separated individually. The number of individual species and biomass in dry weight were recorded and the occurrence of species in each quadrat sampling were also noted.

A line transect with six metre length (marked in every 10 cm) was used. During the study a graduated 5 cm scale also was used for the measurement. In each sampling six observations were randomly made in each part of the system and the intersected vegetation length on the transect were recorded.

3.3.2 Hydrological study

The hydrological study consisted of estimation of salinity, oxygen and nutrients viz. nitrate, nitrite, phosphate and silicate from water samples.

The collection of water sample for the analysis was carried out during the sampling. The water samples were collected in polythene bottles for nutrients and salinity analysis and in incubation bottles for oxygen analysis. At the same time the atmospheric and water surface and bottom temperatures were recorded in each system.

Analysis:

a. Hydrological Data

Analysed according to the modified Winkler method as described by FAO (1975)

b. Salinity:

Estimated by Mohr's titration method.

c. Nitrate:

Determined by the method of Morris & Riley (1963) as described by Parson et al. (1984)

d. Nitrite:

According to the method of Benedeschenider and Robinson (1952) as described by Parson et al. (1984)

e. Silicate:

Determined by the method described by Mullin & Riley (1955).

f. Phospate:

Determined by the method described by Parson et al. (1984).

g. Temperature:

Measured using a 0^{o} to 50^{o} C high precision thermometer.

3.3.3 Meteorological data :

a. Tide :

Data relating to tides were recorded from tide table.

b. Light :

Water transparency and subsurface day light were recorded by using Secchi Disc which was a 30 cm diameter standard white circle. It was used to determine the extinction co-efficient (k) from the following equation. $K = 1.7 / D$. where,

D is the depth at which the disc was just visible.

For rain, relative humidity and wave the data were collected from meteorological department in Port Blair.

3.4 Model:

A model described by Lassiter and Hayne (1971) had been used as a base model for this study. But since the study was totally concentrating on population parameters like frequency, density, coverage, abundance, population size, community level diversity and similarity, it had subsequently been modified and developed in a simple way suitable for the present study. A mathematical model developed by Seip et al. (1979) to study the distribution and abudance of benthic algal species in a Norwegian Fjord and a model constructed by Seip (1980) to study the competition and colonisation in a community of marine benthic algae on the rocky shore of Norwegian Fjord were also referred for this model.

Objectives:

The present model was developed with the following three broad objectives.

1. To obtain population level information in different seasons.

2. To know the details at the community level in different seasons and

3. To know the effect of forcing factors on the systems and their interaction in different seasons.

3.4.1 **Input**:

The following are the inputs of the systems in which the system variables are as follows.

1. The number of individuals of all species in different seasons = SIN.

2. Biomass of all individuals in different seasons = SIB.

3. Number of quadrats in which the species occurs in different seasons = OQN.

4. Total coverage of the species in the transect in different seasons = SCOV.

5. The other constant inputs are as follows.

a. Number of systems (x)	=	5 (X1 to X5) X1 to X5
b. Intertidal Part (IT)	=	5 (A1)

c.	Subtidal Part (ST)	= 5 (A2)
d.	Total number of species	= 35 (TNS)
e.	Other algae group species (OA)	= 19 (OAS)
f.	Alginophyte group species (AL)	= 10 (ALS)
g.	Agarophytes group species (AG)	= 6 (AGS)
h.	Total Climax species (CS)	= 11 (TCS)
i.	Total Seral species (SS)	= 24 (TSS)
j.	Quadrat area	= 0.25 sq. m^2 (QA)
k.	Total no. of Quadrats in a part during sampling	= 10 (TQN)
l.	Total quadrat area in each part during sampling	= 2.50 sq. m^2 (TQA)
m.	Line transect length	= 6 m (LTL)
n.	Total no. of line transects studied during sampling in a part	= 6 Nos. (TLTN)
o.	Total line transect length in a part during sampling	= 6 m (TLTL)

6. The forcing factors specific to the system are as follows:

I. **Intertidal Part:**

a.	Atmospheric temperature	= ATMT
b.	Water temperature	= WT
c.	Salinity	= SAL
d.	Dissolved oxygen	= DO2
e.	Phosphate	= PO4

f. Nitrate = NO3

g. Nitrite = No2

h. Silicate = SI

II. **Subtidal Part**

a. Water temperature = WT

b. Light = light

c. Salinity = SAL

d. Dissolved oxygen = DO2

e. Phosphate = PO4

f. Nitrate = NO3

g. Nitrite = No2

h. Silicate = SI

7. The common forcing factors to the systems are as follows:

A. **Intertidal part:**

a. Tide = TID

b. Rain = RN

c. Relative humidity = RH

d. Wave = WA

B. **Subtidal part:**

a. Tide = TID

b. Wave = WA

c. Depth = DEP

3.4.2 Transfer functions:

A. Population level:

1. Frequency

$$FRE = OSIQ/TQN \times 100$$

1a. Relative frequency

$$RF = SIN/TNOAS$$

2. Abundance

$$AB = SIN/OQN$$

3. Density

$$DEN = SIN/TQN$$

3a. Relative Density

$$RDEN = SIN/TNOIN \times 100$$

4. Cover

$$\% \ Cov = LCBS/TLTL \times 100$$

5. Index of Dominance

$$C = E\ (Ni/N)^2 \qquad E = Sigma$$

6. Dispersion pattern (Morista's Index)

$$IS = \frac{N(EX^2 - EX)}{(EX)^2 - EX}$$

6a. Statistical distribution (Poisson distribution)

$$S^2 = \frac{(fx^2) - f(x)^2 \quad / N}{N - 1}$$

1. OSIQ = Number of quadrats in which the species occurs.

1a.	TNOAS	=	Total number of Individuals of all species.
1a & 2	SIN	=	Total number of individuals of single species.
3a.	TNOIN	=	Total number of individuals of all species.
4.	LCBS	=	Length covered by a species in all transects.
4.	TLT	=	Total length of the transect
5.	Ni	=	Total number of individuals of a single species
5.	N	=	Total number of individuals of all species.
6.	N	=	Total number of samples
6.	x	=	Number of individuals per sample
6a.	S^2	=	Variance
6a.	f	=	frequency of x
6a.	N	=	Total number of samples.
6a.	x	=	Number of individuals per sample.

B. Community Level

a. Community composition.

1 Simpson's diversity

$$D = 1-\sum_{i=1}^{s} (ni/N^2)$$

2. Shannon - Weaver diversity

$$\bar{H} = \sum^{s} = [ni / N] \log [ni / N]$$

1. D = Simpson's index

   S = Number of species

   ni = Important value for each species

   N = Total of important value

2. $\bar{H}$ = Shannon Index

b. Community comparison

1. Index of similarity

$$Is = \frac{J}{(a = b) - J}$$

2. Quotient of similarity

$$Qs = \frac{2J}{a + b}$$

J = Number of Common species

a = Number of species in habitat x

b = Number of species in habitat y

4. RESULTS

A diagramatic illustration about the approach of results has been given in Figure 9.

4.1 QUALITATIVE ASPECTS (Species Composition)

4.1.1 Seaweed Species in different islands (Annexure I)

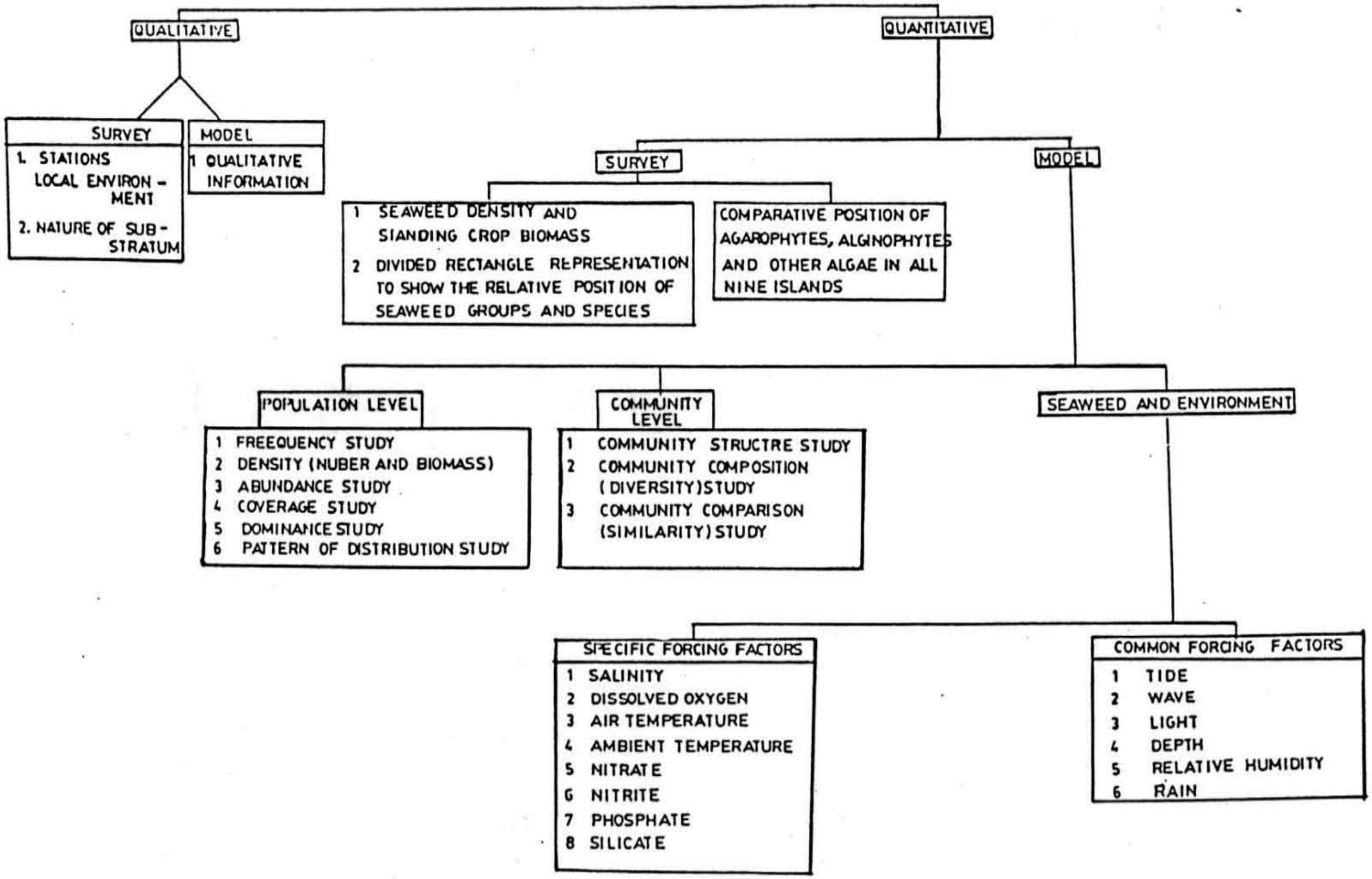
A total number of 79 species of seaweeds were recorded from 9 islands of Andaman and Nicobar group of islands during the study.

1. SOUTH ANDAMAN

In South Andaman the seaweeds contribute 55 species. The major algal divisions such as Chlorophyta, Phaeophyta and Rhododphyta are represented by 29, 15 and 11 species respectively. Out of the 55 species only 35 species are quantitatively studied in detail because of the available quantity. The topography of the island is hilly. From North Point upto Chatham (Fig.2) the bottom is muddy, in which the area from North Point to Mini Bay, the intertidal part is full of mangrove vegetation and the seaweed vegetation is very poor in distribution. In Chatham, which is a small island connected to Port Blair by a bridge, due to the timber factory located in this region is polluted with saw dust and timber wastes along the coast and devoid of normal algal vegetation. From Blair reef to Wandoor the

FIGURE - 9

RESULTS AND APPROACH



intertidal area is mingled with rocky, sandy and muddy substratum. From Cheriadapu to Wandoor the area is of luxuriant mangrove vegetation. The coral distribution was also observed in most of the stations in good condition. The Sargassum spp. are growing in the Burmanala and Cheriadapu of considerable quantity. The eastern area of South Andaman is highly affected by strong wave and heavy breakers on flat rocks at low tide. In intertidal part, the area without mangroves has normal seaweed vegetation but in general intertidal vegetation was very poor. Here the other algae group dominates than agarophytes and alginophytes. Polluted shoreline near Chatham, over humidity, muddy bottom and presence of mangrove vegetation may be the factors for less seaweed vegetation in this region. Normal seaweed vegetation is observed in the subtidal part except in some backwater side. Here the limiting factors are healthy coral distribution and muddy bottom. The alginophytes were in luxurious growth in some of the stations (Burmanala, Cheriadapu, Wandoor, and North Point). But in general the agarophytes were completely supressed in distribution. The important alginophytes with better distribution are listed below.

1. Padina gymnospora
2. Sargassum wightii
3. Sargassum myriosystem

4. Sargassum ilicifolium
5. Sargassum duplicatum
6. Turbinaria ornata
7. Turbinaria conoides
8. Turbinaria turbinata

The agarophytes were observed in considerable quantity in some of the stations. They are listed below.

1. Gelidiella acerosa
2. Gelidium heteroplatus
3. Gracilaria edulis
4. Gracilaria crassa
5. Gracilaria folifera

In the other group of algae, the Halimeda spp., Acetabularia, Chaetomorpha and Amphiroa spp. were the important species with better vegetation.

2. **MAYABUNDER** (Middle Andaman)

The topography of Mayabunder area is hilly and the maximum elevation is 67m. The Jetty area has a limited sandy beach, otherwise, shore is muddy with abundant mangrove vegetation. Only the Eastern side of the island was studied, as the weather condition prevailing in the Western side was not congenial for survey. In most of the intertidal part the shore line with fully covered mangrove vegetation was noticed and corresponding poor seaweed vegetation was observed ie. only limited vegetation was observed. The subtidal part has healthy live coral assemblages and the seaweed vegetation was very limited, however comparing with intertidal part, the vegetation in subtidal part was more. Among the seaweed vegetation, the alginophytes were the dominating species.

The important species are listed below.

1. Padina gymnospora
2. Sargassum wightii
3. Sargassum ilicifolium
4. Turbinaria ornata
5. Turbinaria conoides

These species were observed only in the subtidal part in most of the stations. The distribution of agarophytes was sparse and also the plants were in poor condition when compared to alginophytes. Gelidium sp. and Gracilaria sp. were noticed in growing stages. They were in negligible quantity for quantitative analysis. Among the other group of algae, Amphiroa sp. and Halimeda sp. were in better distribution.

3. DIGLIPUR (NORTH ANDAMAN)

The topography of Diglipur area is hilly and maximum elevation of 76m. The Western shallow Bay area is lined by mangroves and muddy with coral stones. Southern stretch is free of mangroves. Bottom of the sea is a mixture of sand and mud mingled with coral patches. During the period of study only the Eastern side of the island was surveyed as the weather condition prevailing in the Western side was not congenial for survey. The intertidal part, due to muddy, sandy substratum and luxurious mangrove vegetation, the seaweed vegetation was completely supressed in this area. The mangrove less Southern side of the shoreline with rocky substratum (Fig.4) also was observed with poor seaweed vegetation. For this area, further study in different seasons will give more details, since most of the suitable places for seaweed growth are of limited or very poor in vegetation. The subtidal part also have the mud mingled with coral patches. In this area water is not clear, since the silt is too much and there by seaweed vegetation is poor in distribution. Among the seaweed vegetation, the alginophytes were the dominating species. The important species are listed below.

1. *Dictyota dichotoma*
2. *Padina gymnospora*
3. *Sargassum wightii*
4. *Sargassum ilicifolium*
5. *Turbinaria ornata*
6. *Turbinaria conoides*
7. *Turbinaria turbinata*

The agarophytes had a sparse distribution in this area and the plants were also found to be in poor condition when compared to alginophytes. Gelidium sp. and Gracilaria sp. were noticed in poor quantities and are negligible for quantitative analysis. Among other group of algae, Amphiroa sp and Halimeda sp. were in better distribution.

4. **NEIL ISLAND**

In Neil the seaweeds contributed 24 species. In the economical point of view the agarophytes, alginophytes and other algae are represented by 3, 7, and 14 species respectively. The intertidal part is covered by mangrove vegetation in most of the area. The seaweeds also have normal vegetation in most of this area. From the subtidal part luxurious algal growth is recorded. The important alginophytes with dense population are,

1. Padina gymnospora
2. Sargassum wightii
3. Sargassum ilicifolium
4. Turbinaria ornata
5. Turbinaria conoides
6. Turbinaria deccurrence
7. Turbinaria turbinata

and agarophytes species are,

1. Gracilaria edulis
2. Gracilaria crassa
3. Gracilaria folifera

Apart from this the other algae like Enteromorpha compressa, Halimeda sp. and Laurencia sp. showed good vegetation.

5. HAVELOCK ISLAND

A total number of 22 seaweed species are recorded from Havelock. Agarophytes, alginophytes and other algae are represented by 2, 7 and 13 species respectively. Except Kalapathar creek, rest of the intertidal part supported dense algal vegetation. Domination of alginophytes were noticed in the subtital part. Here dense vegetation of the same was observed. In this island almost all alginophytes were observed with dense vegetation in the intertidal part. They are,

1. Padina gymnospora
2. Padina tetrastomatica
3. Sargassum wightii
4. Sargassum ilicifolium
5. Turbinaria ornata
6. Turbinaria conoides
7. Turbinaria turbinata

Among agarophytes Gracilaria crassa and G. folifera were noticed and among other algae the species of Chaetomorpha, Enteromorpha and Laurencia were the important ones.

6. CAR NICOBAR ISLAND

The topography of Car Nicobar area is terrain, with a maximum elevation of 72 m. Most of the intertidal area are rocky and some of them are sandy and devoid of mangrove vegetation. In most of the area the dead reef will be exposed to about 50-250 m. from the shore at low tide. Strong wave action with heavy breakers on flat rocks at low tide is noticed and also here the depth of the sea abruptly increases with heavy currents. This is observed in some of the areas especially from Thammalee to Jayanthy village. Due to the rocky substratum most of the intertidal area are with excellent seaweed vegetation. A large variety of seaweed species are competing here to grow in this area. Different species of agarophytes and some members of alginophytes grow only in intertidal area. In addition to this many other algae groups were also observed. This sort of vegetation of high quantity were found upto the dead coral reef area.

The subtidal area is distributed with live corals and sand with dead coral parts also. Hence the seaweed vegetation was very poor in distribution. A total number of

31 species were studied in detail during this survey. Among these agarophytes, alginophytes and other algae were represented by 6, 6 and 19 species respectively. Among the seaweed vegetation after other algae group, the agarophytes were dominating with luxurious vegetative distribution but their representation was only in the intertidal part and which is exposed to about 50 to 300 m. from shore at low tide. The important species are listed below.

1. Gelidiella acerosa
2. Gracilaria edulis
3. Gracilaria crassa
4. Gracilaria folifera
5. Gracilaria corticata
6. Gracilaria indica
7. Hypnea valentiae

The alginophytes were observed only from Arong to kimos shore line area. In Arong region Sargassum sp. was found to be luxuriant in vegetation, Padina sp showed normal distribution while Turbinaria spp. were very sparse in distribution. Among the other group of algae the Halimeda and Amphiroa sp were dominant in inshore area and in intertidal part the Enteromorpha sp., Ulva sp., and Acantho phora sp. were dominant in distribution.

7. TERASSA ISLAND

The topography of the Teressa area is hilly. Most of the intertidal parts are rocky and some of them are sandy. Near the Bengali station mangroves vegetation were observed and the other stations were devoid of mangroves. Strong waves with heavy breakers were observed on flat rocks at lowtide in Western side. Distribution of seaweeds were good in intertidal region only in few areas and rest of the area were with better subtidal vegetation. It was observed that most of the rocky intertidal part with poor vegetation, where as in subtidal part the corals were in healthy distribution and seaweeds were observed only in the dead coral rocks. And here no seaweed group was observed with dominant vegetation. Alginophytes were observed but not in considerable quantity. The agarophytes are listed below.

1. *Gracilaria edulis*
2. *Gracilaria crassa*

and the alginophytes are

1. *Padina gymnospora*
2. *Turbinaria turbinata*
3. *Turbinaria conoides*
4. *Sargassum ilicifolium*

Among the other group of algae the *Halimeda* sp., *Amphiroa* sp., and *Laurencia* sp., were observed in better distribution.

8. CHOWRA ISLAND

The topography of the island is plane and hilly in the South corner. The intertidal part is sandy in the windward side. Sand deposition and erosion in different seasons are noticed. The island is devoid of mangroves, but the coral distribution is healthy and the seaweed vegetation is normal. The intertidal part is covered with rock and sand, the seaweeds are even in distribution in rocky substrated area. The subtidal area is full of corals and the seaweed vegetation is completely supressed. The agarophytes and the alginophytes are equally distributed in the intertidal part. The important alginophytes are,

1. Padina gymnospora
2. Padina tetrastomatica
3. Sargassum ilicifolium
4. Sargassum wightii
5. Turbinaria ornata
6. Turbinaria turbinata
7. Turbinaria dentata

and the agarophytes are

1. Gracilaria edulis
2. Gracilaria corticata
3. Gelidiella acerosa
4. Gelidium regidum

Among other group of algae Lithophyllum sp., Acanthophora sp., Halimeda sp.& Laurencia sp. were dominant in distribution.

9. BUMPOKA ISLAND

The topography is hilly, most of the intertidal part is rocky while Eastern part is sandy. Here less seaweed vegetation is noticed and corals are healthy in distribution. A total number of 20 species from agarophytes, alginophytes and other algae were represented by 2, 6 and 12 species respectively.

The important species of alginophytes are

1. Padina tetrastomatica
2. Padina gymnospora
3. Turbinaria turbinata
4. Turbinaria conoides
5. Sargassum ilicifolium
6. Sargassum wightii

and agarophytes are

1. Gelidiella acerosa
2. Gracilaria corticata

Among the other group of algae Halimeda sp, Amphiroa sp, Acanthophora sp. and Chaetomorpha sp. are dominant in distribution.

4.1.2 Seaweeds of South Andaman for the Model Study

A total number of 55 seaweed species were recorded from the five different stations of South Andaman. Tables (13, a,b & c) show the seaweed species collected from the different stations during the present study. The stations 1 to 5 are observed with 24, 27, 33, 36 and 33 seaweed species respectively. The species which are available in all seasons are grouped into climax communities. Regarding this a total number of eight species were considered as climax community species. Since the model study deals with quantitative aspects of the seaweeds, after leaving the seaweeds of negligible quantities only 35 species were considered for the model study, in which the agarophytes, alginophytes and other algae represent 6, 10 and 19 species respectively. The availability of seaweeds in the intertidal and subtidal part of all 5 stations during the 3 seasons (premonsoon, monsoon, postmonsoon) are presented in table 13a, 13b, and 13c in which the stations 3, 4, and 5 show more number of species in all seasons.

The important species of alginophytes are

1. *Padina gymnospora*
2. *Padina tetrastomatica*
3. *Sargassum ilicifolium*
4. *Sargassum wightii*
5. *Sargassum myriosystem*

6. Turbinaria ornata
7. Turbinaria turbinata
8. Turbinaria dentata

and the agarophytes are

1. Gracilaria edulis
2. Gracilaria corticata
3. Gelidiella acerosa
4. Gelidium regidum

4.2 QUANTITATIVE ASPECT

4.2.1 Survey

A. **Density and standing crop biomass of seaweeds**

The results obtained from the survey data of 9 islands have been represented in the form of density and standing crop biomass in fresh weight for the different groups like agarophytes, alginophytes, and other algae to know the individual group representation (Table 1 to 11) and to get the percentage of total standing crop (fresh weight) of 3 major groups and individual species composition within each major groups are expressed in the form of divided rectangle picutres. (Fig.10 to 18)

(i) South Andaman

The overall density of seaweeds in South Andaman is 619.67 $\pm$ 247.07 g/m^2 comprising **35** species. Among these, agarophytes constitute 32.35 ± 16.27 g/m^2 with 6 species; alginophytes 365.57 ± 145.15 g/m^2 with 10 species and the other algae 221.75 ± 85.65 g/m^2 with 19 species. While the biomass of seaweeds in tonnes represent 19110.68 ± 8146.60, the individual values for agarophytes are being 2266.39 ± 778.67; alginophytes 10458.97 ± 4191.90 and for other algae 6385.32 ± 3176.03 for a total area of 401.00 hectares. The density and standing crop biomass of the South Andaman seaweeds are shown in the table 1 and shows that in South Andaman alginophytes grow abundantly. The most important alginophytes in biomass of this island are *Sargassum wightii* with 47.23 ± 19.49 g/m^2, *S. myriosystem* with 66.54 ± 21.34 g/m^2; *S. ilicifolium* with 58.52 ± 23.12 g/m^2 and *Turbinaria turbinata* with 48.23 ± 15.38 g/m^2.

The percentage of total standing crop (fresh weight) by 3 major groups (agarophytes, alginophytes, and other algae) and individual species composition in each major group are represented in the form of divided rectangles (Fig.10). The horizontal portion shows the groupwise relative percentage and the vertical portion expresses the relative percentage of species in its own group. In South Andaman, the most important category of the seaweed group is the alginophytes (54.05%). Their high percentage is especially remarkable when compared to that of other algae group (34.23%) and agarophytes (11.72%). Here

TABLE - 1

Density and Standing Crop Biomass of Seaweeds

SOUTH ANDAMAN

No	SPECIES	DENSITY g / m²		STANDINGCROP BIOMASS IN TONNES	
		Average	Sd	Average	Sd
	AGAROPHYTES				
1	*Gelidiella acerosa*	11·09	6·31	541·76	352·18
2	*Gelidium heteroplatos*	2·08	1·04	173·88	41·68
3	*Gracilaria edulis*	4·45	1·39	1009·94	89·28
4	*G. corticata*	4·81	2·71	169·35	96·38
5	*G. crassa*	6·62	3·19	263·93	132·77
6	*G. folifera*	3·30	1·63	107·53	66·38
	Total	32.35	16.27	2266.39	778.67
	ALGINOPHYTES				
1	*Padina gymnospora*	30·39	15·43	944·43	315·43
2	*P. tetrastomatica*	37·87	17·33	1260·96	529·04
3	*Sargassum wightii*	47·23	19·49	1312·80	510·97
4	*S. myriosystem*	66·54	21·34	1694·50	646·47
5	*S. ilicifolium*	58·52	23·12	1347·11	478·20
6	*S. duplicatum*	24·94	12·14	740·51	442·33
7	*Turbinaria ornata*	22·02	9·83	849·21	311·33
8	*T. conoides*	29·83	11·09	754·37	311·63
9	*T. turbinata*	48·23	15·38	1555·08	646·50
	Total	365.57	145.15	10458.97	4191.90
	OTHER ALGAE				
1	*Enteromorpha compressa*	11·17	9·41	600·34	223·96
2	*Ulva lactuca*	5·51	2·69	235·55	110·39
3	*U. reticulata*	6·53	3·19	154·61	130·89
4	*Chaetomorpha antennina*	8·57	4·83	226·45	97·92
5	*Caulerpa peltata*	4·88	1·41	107·76	102·11
6	*C. racemosa*	5·89	2·32	114·47	129·16
7	*C. taxifolia*	6·44	3·14	136·98	73·05
8	*Codium tomentosum*	3·64	1·03	145·30	68·31
9	*Halimeda incrassata*	58·53	19·73	1786·03	671·61
10	*H. peltata*,	68·72	21·87	1552·93	910·14
11	*Dictyota dichotoma*	25·72	9·41	579·21	300·12
12	*D. bartyressiana*	3·00	1·04	88·69	41·43
13	*Hydroclathrus clathratus*	2·41	1·12	119·56	34·71
14	*Amphiroa fragillassima*	1·20	0·92	64·88	22·21
15	*Galaxaura oblongata*	0·81	0·34	56·30	26·83
16	*Centroceros clavulatum*	1·18	0·43	108·66	39·76
17	*Ceramium avalona*	1·13	0·33	153·38	42·12
18	*Laurencia papillosa*	1·78	0·94	154·22	32·18
19	*Acetabularia sps*	4·64	1·41	238·31	101·32
	Total	221.75	85.65	6385.32	3176.03
	Grand Total	619·67	247·07	19110·68	8146·60

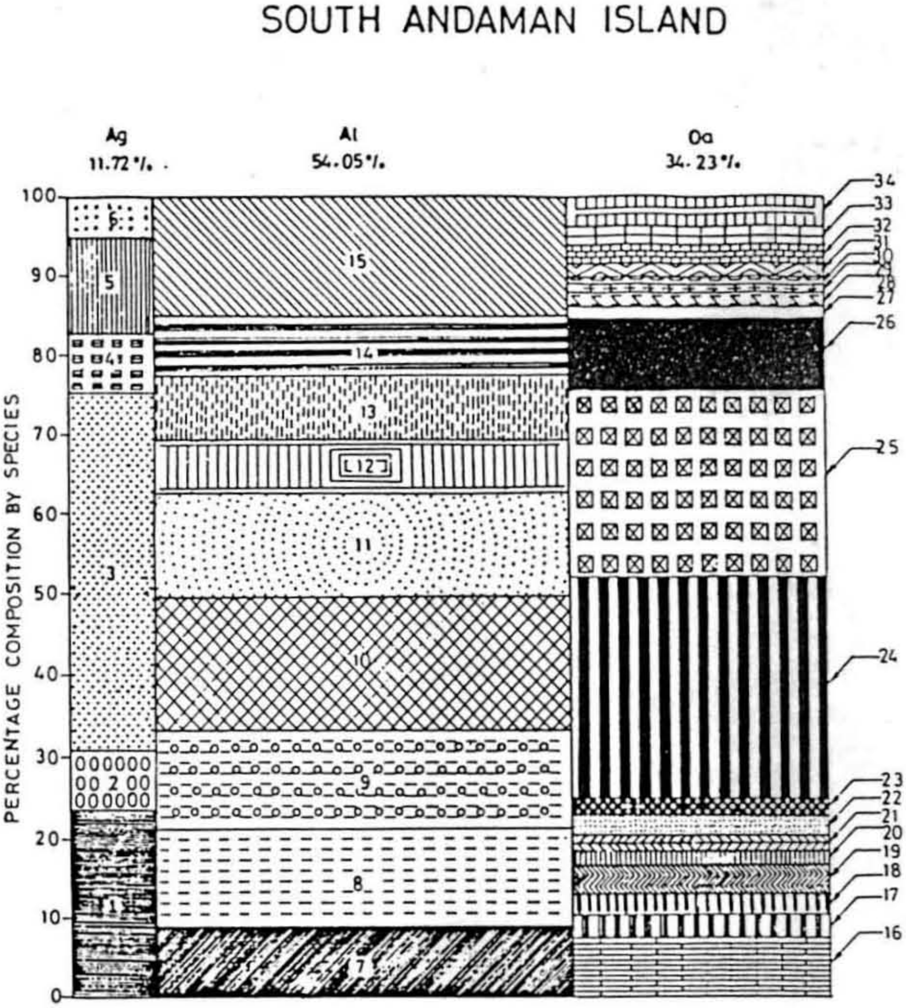


FIGURE - 10

DIVIDED RECTANGLE SHOWING PERCENTAGE OF TOTAL STANDING CROP (WEIGHT) BY MAJOR GROUP AND SPECIES COMPOSITION WITHIN EACH MAJOR GROUP

Ag – Agarophytes Al – Alginophytes Oa – Other algae

1 Gelidiella acerosa
2 Gelidium heteroplatos
3 Gracilaria edulis
4 Gracilaria crassa
5 Gracilaria folifera
6 Gracilaria corticata
7 Padina gymnospora
Padina tetrastromatica > 8
9 Sargassum wightii
10 Sargassum myriosystem
11 Sargassum illicifolium
12 Sargassum duplicatum
13 Turbinaria ornata
14 Turbinaria conoides
15 Turbinaria turbinata
16 Enteromorpha compressa
17 Ulva laducc
18 Ulva reticulata
19 Chaetomorpa artennina
20 Caulerpa peltata
21 Caulerpa racemosa
22 Caulerpa taxifolia
23 Codium tomentosum
24 Halimeda incrassata
25 Halimeda peltata
26 Dictyota dichotoma
27 Dictyota bartyressiana
28 Hydroclathrus clathratus
29 Amphiroa fragilissima
30 Galaxaura oblongata
31 Centroceras clavulatum
32 Ceramium avalona
33 Laurencia papillosa
34 Acetabularia

the alginophytes are the principal component, contributing 54.05% with economically important species like Sargassum sp and Turbinaria sp, the relative percentage are shown in the figure.

(ii) Mayabunder (Middle Andaman)

In Mayabunder the overall density of seaweeds is 151.06 $\pm$ 66.11 g/m^2 comprising 15 species. Among these alginophytes constitute 113.18 $\pm$ 50.90 g/m^2 with eight species and other algae group constitutes 37.88 $\pm$ 15.21 with seven species, since the agarophytes are less in quantity during the period of study they are not included. While the total standing crop biomass of seaweeds represent 3384.78 $\pm$ 1480.71.t, with alginophytes 2536.18 $\pm$ 1140.25 t and other algae 848.60 $\pm$ 340.46t for a total area of 224.06 ha. The density and standing crop biomass of Mayabunder are presented in Table 2, and illustrate that here seaweeds are very less in vegetation, the reason may be the one which are discussed in the qualitative aspects of Mayabunder.

The divided rectangle shows 74.93% of alginophytes and 25.07% of other algae. (Fig. 11) Even in this low vegetation the alginophytes show very good concentration in these areas, and since the Middle Andaman area (Mayabunder) have a lot of culture sites, with the help of further

TABLE - 2

Density and Standing Crop Biomass of Seaweeds

MAYABUNDER (Middle Andaman)

No	SPECIES	DENSITY g/m^2		STANDINGCROP BIOMASS IN TONNES	
		Average	Sd	Average	Sd
	AGAROPHYTES Meager and negligible for quantitative study	---	---	---	---
	ALGINOPHYTES				
1	*Dictyota dichotoma*	7·16	3·93	160·48	88·01
2	*Padina gymnospora*	12·87	5·55	288·27	124·20
3	*Hormophysa triquetra*	19·79	14·98	443·50	335·59
4	*Sargassum wightii*	20·10	8·72	450·38	95·29
5	*S. ilicifolium*	15·29	5·56	342·66	124·53
6	*Turbinaria ornata*	14·44	4·79	323·63	107·30
7	*T. conoides*	16·57	4·88	371·24	109·52
8	*T. turbinata*	6·93	2·49	156·02	55·81
	Total	113.18	50.90	2536.18	1140.25
	OTHER ALGAE				
1	*Enteromorpha compressa*	2·00	1·14	44·74	25·52
2	*Caulerpha peltata*	2·37	1·28	53·15	28·69
3	*C. taxifolia*	2·57	1·33	57·59	29·77
4	*Halimeda incrassata*	13·02	4·30	291·67	96·20
5	*Amphiroa fragillissima*	14·85	5·03	332·69	112·62
6	*Centroceros clavulatum*	1·65	1·23	34·99	27·45
7	*Laurencia papillosa*	1·51	0·90	33·77	20·21
	Total	37.88	15.21	848.60	340.46
	GRAND TOTAL	151·06	66·11	3384·78	1480·71

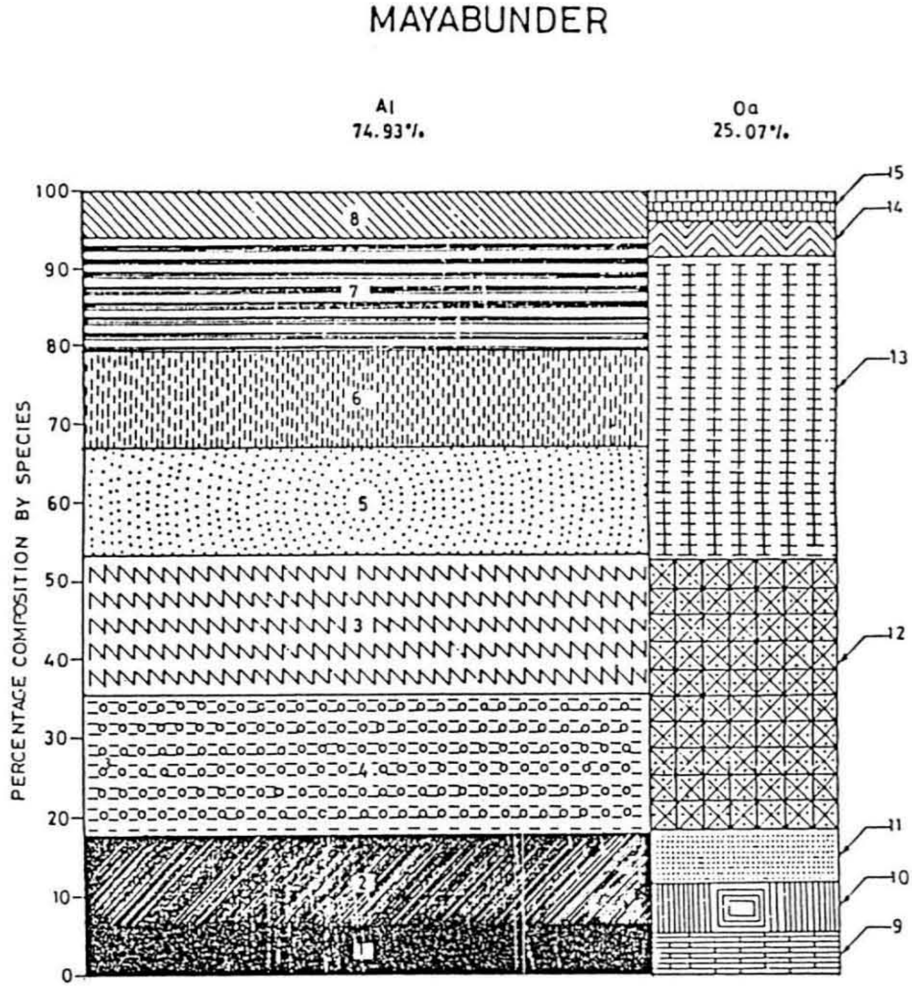


FIGURE - 11

DIVIDED RECTANGLE SHOWING PERCENTAGE OF TOTAL STANDING CROP (WEIGHT) BY MAJOR GROUP AND SPECIES COMPOSITION WITHIN EACH MAJOR GROUP

Ag – Agarophytes Al – Alginophytes Oa – Other algae

1 Dictyota dichotoma
2 Padina gymnospora
3 Hormophysa triquetra
4 Sargassum wightii
5 Sargassum illicifolium
6 Turbinaria ornata
7 Turbinaria conoides
8 Turbinaria turbinata
9 Enteromorpha compressa
10 Caulerpa peltata
11 Caulerpa taxifolia
12 Halimeda incrassata
13 Amphiroa fragillasima
14 Centeroceras clavulatum
15 Laurencia papillosa

research in these area, there is a possibility to increase the alginophytes vegetation by means of artificial culture or natural culture. Here all alginophytes show good representation.

(iii) Diglipur (North Andaman)

In Diglipur which comes under the North Andaman islands a total number of 12 species are considered for studying the density and standing crop biomass. Here also since the agarophytes are less in quantity, they are not included (Table-3). In a total area of 247.77 ha, the total density and standing crop biomass are 138.53 ± 28.75 g/m^2 and 3432.31 ± 1607.60t. In comparison with Mayabunder here also eventhough the seaweed vegetation is poor, the alginophytes show good response with density and biomass of 110.65 ± 17.11 g/m^2 and 2741.43 ± 1188.15t than the other algae group with density and biomass of 27.88 ± 11.64 g/m^2 and 690.88 ± 419.45t.

From divided rectangle results, it is very clear that the Mayabunder of Middle Andaman and Diglipur of North Andaman have similar type of vegetation (Fig. 11 and 12). The alginophytes show significantly high percentage of 79.87 when compared to the other algal groups (20.13%). Here also almost all alginophytes show good representation.

TABLE - 3

Density and Standing Crop Biomass of Seaweeds

DIGLIPUR (North Andaman)

No	SPECIES	DENSITY g / m²		STANDINGCROP BIOMASS IN TONNES	
		Average	Sd	Average	Sd
	AGAROPHYTES Meager and negligible for quantitative study	---	---	---	---
	ALGINOPHYTES				
1	*Dictyota dichotoma*	8·62	0·74	213·49	148·32
2	*Padina gymnospora*	13·89	1·10	344·20	129·31
3	*Sargassum wightii*	29·47	3·09	730·20	210·14
4	*S. ilicifolium*	26·42	2·55	654·58	343·03
5	*Turbinaria ornata*	17·24	2·89	427·19	179·31
6	*T. conoides*	6·50	3·89	161·01	84·32
7	*T. turbinata*	8·51	2·85	210·76	93·72
	Total	110.65	17.11	2741.43	1188.15
	OTHER ALGAE				
1	*Enteromorpha compressa*	1·45	1·00	36·05	12·43
2	*Caulerpa peltata*	3·91	1·21	96·81	34·49
3	*Halimeda incrassata*	9·24	3·43	229·02	119·63
4	*Amphiroa fragillissima*	6·34	3·31	157·00	121·47
5	*Centroceros clavulatum*	6·94	2·69	172·00	131·43
	Total	27.88	11.64	690.88	419.45
	GRAND TOTAL	138·53	28·75	3432·31	1607·60

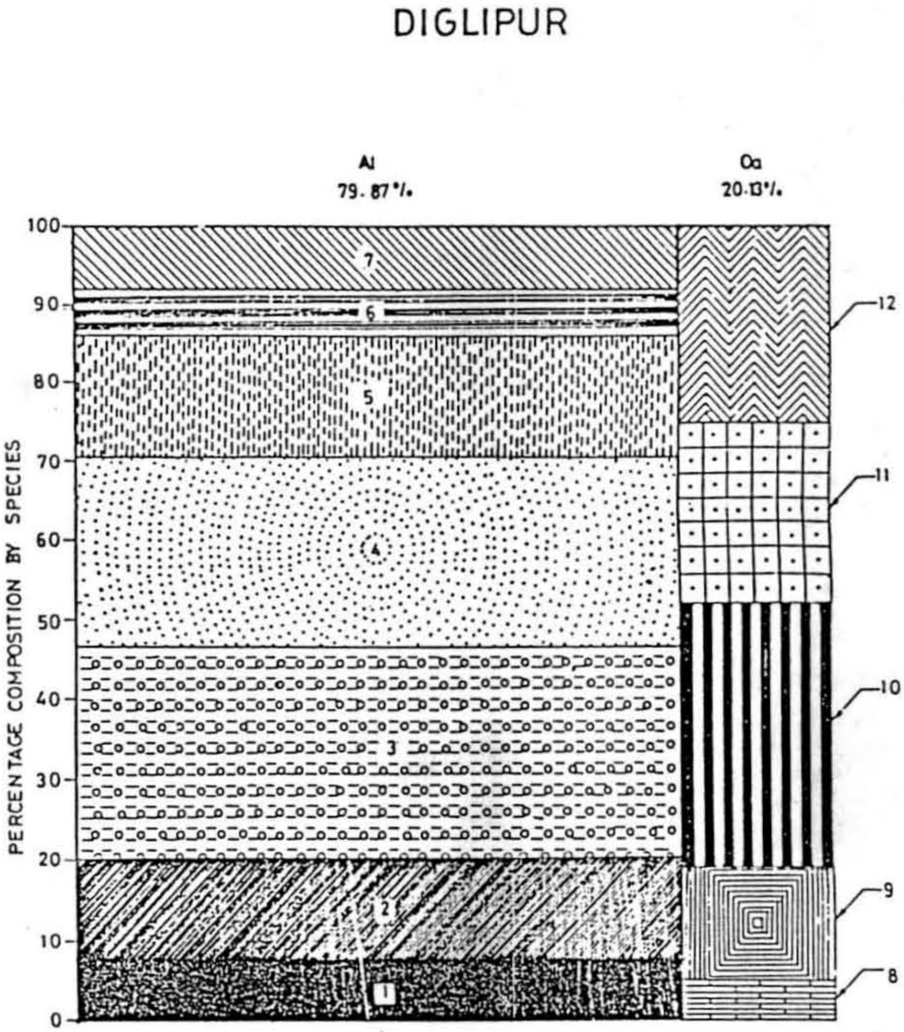


FIGURE - 12

DIVIDED RECTANGLE SHOWING PERCENTAGE OF TOTAL STANDING CROP (WEIGHT) BY MAJOR GROUP AND SPECIES COMPOSITION WITHIN EACH MAJOR GROUP

Al - Alginophytes   Oa - Other algae

1 Dictyota dichotoma	7 Turbinaria turbinata
2 Padina gymnospora	8 Enteromorpha compressa
3 Sargassum wightii	9 Caulerpa peltata
4 Sargassum illicifolium	10 Halimeda incrassata
5 Turbinaria ornata	11 Amphiroa fragillessima
6 Turbinaria conoides	12 Centeroceras clavulctum

(iv) Neil

In Neil Island, the total density and standing crop biomass calculated for the 24 species are 582.14 ± 213.54 g/m^2 and 15712.93 ± 5462.13t in a total area of 269.91 ha. (Table 4) Here the alginophytes are represented with excellent density and biomass of 270.41 ± 98.75 g/m^2 and 7298.91 ± 2364.99t, when compared to agarophytes with a low density and biomass of 29.99 ± 20.15 g/m^2 and 809.56 ± 543.67t. The individual representation of each species are given in the table No. 4. The divided rectangle representation of Neil Island exhibits some what equal representation of percentage for agarophytes and other algae of 46.45 and 48.40 but the agarophytes occupies very small portion with 5.15%. (Fig. 13) Anyhow compared to Mayabunder and Diglipur islands, here at least the agarophytes have their own representation. Sargassum wightii of alginophyte and Halimeda opuntia of other algae appear with dominant representation. But the other algae group also shows notable density and biomass of 281.73 ± 94.64 g/m^2 and 7604.46 ± 2553.47t.

(v) Havelock

Over all density and biomass of 420.70 ± 140.71 g/m^2 and 18849.71 ± 5970.29 t are exhibited by 22 seaweed species in an area of 424.42 ha, in which the alginophytes

TABLE - 4

Density and Standing Crop Bimass of Seaweeds

NEIL ISLAND

No	SPECIES	DENSITY g／m²		STANDING CROP BIOMASS IN TONNES	
		Average	Sd	Average	Sd
	AGAROPHYTES				
1	*Gracilaria edulis*	15·95	14·30	430·46	386·01
2	*G. crassa*	5·45	2·23	147·17	60·15
3	*G. folifera*	8·59	3·62	231·93	97·51
	Total	29.99	20.15	809.56	543.67
	ALGINOPHYTES				
1	*Padina gymnospora*	36·02	8·25	972·23	222·57
2	*P. tetrastomatica*	19·14	7·10	516·64	191·49
3	*Sargassum wightii*	57·38	15·17	1548·84	409·37
4	*S. illicifolium*	36·05	13·96	972·04	376·65
5	*Turbinaria ornata*	48·81	30·12	1317·42	513·02
6	*T. conoides*	37·81	10·29	1020·54	277·73
7	*T. decurrence*	35·24	13·86	951·20	374·16
	Total	270.41	98.75	7298.91	2364.99
	OTHER ALGAE				
1	*Enteromorpha compressa*	12·99	6·03	350·69	162·80
2	*Ulva lactuca*	8·33	4·21	224·78	113·63
3	*Chaetomorpha antennina*	6·33	3·27	170·93	88·08
4	*Cladophora utriculata*	10·57	3·71	285·32	100·67
5	*Caulerpa peltata*	3·08	0·99	83·19	26·76
6	*C. racemosa*	5·67	1·77	152·93	47·82
7	*C. taxifolia*	4·49	2·19	121·26	58·93
8	*C. sertularoides*	5·50	3·29	148·47	88·86
9	*Codium tomentosum*	2·63	1·47	71·10	39·54
10	*Halimeda opentia*	86·17	19·76	2325·73	533·05
11	*H. incrassata*	58·29	19·27	1573·33	520·01
12	*H. discoideae*	43·72	17·54	1180·06	473·37
13	*Laurencia papillosa*	23·18	6·18	625·73	166·73
14	*L. obtusa*	10·78	4·96	290·94	133·92
	Total	281.73	94.64	7604.46	2553.47
	GRAND TOTAL	582·14	213·54	15712·93	5462·13

NEIL ISLAND

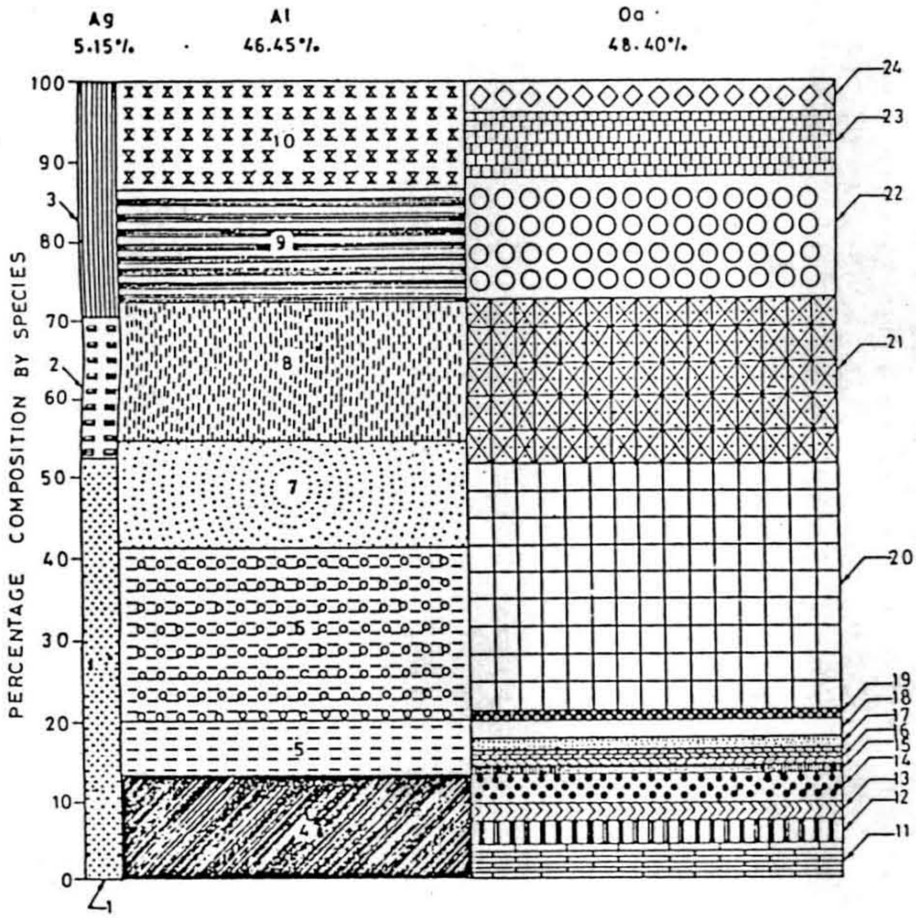


FIGURE - 13

DIVIDED RECTANGLE SHOWING PERCENTAGE OF TOTAL STANDING CROP (WEIGHT) BY MAJOR GROUP AND SPECIES COMPOSITION WITHIN EACH MAJOR GROUP

Ag – Agarophytes   Al – Alginophytes   Oa – Other algae

1	Gracilaria edulis	13	Chaetomorpha antennina
2	Gracilaria crassa	14	Cladophora utriculosa
3	Gracilaria folifera	15	Caulerpa peltata
4	Padina gymnospora	16	Caulerpa racemosa
5	Padina tetrastromatica	17	Caulerpa taxifolia
6	Sargassum wightii	18	Caulerpa sertularioides
7	Sargassum illicifolium	19	Codium tomentosum
8	Turbinaria ornata	20	Halimeda opuntia
9	Turbinaria conoides	21	Halimeda incrassata
10	Turbinaria decurrence	22	Halimeda discoideae
11	Enteromorpha compressa	23	Laurencia papillosa
12	Ulva lactuca	24	Laurencia obtusa

show a remarkable domination against other groups with the density and biomass of 361.60 ± 94.79 g/m^2 and 15347.37 ± 4021.99t. The density and biomass of other algae groups being 59.10 ± 29.04 g/m^2. and 2508.32 ± 1232.14 t and for agarophytes 23.48 ± 16.88g/m^2 and 994.02 ± 716.16 t (Table 5). In the divided rectangle (Fig. 14) the alginophytes, which is the most important category among the three groups show noticeable percentage of 81.42 when compared to other groups, percentage of agarophytes and other algae being 5.27 and 13.31 respectively. Moreover, Turbinaria conoides, Turbinaria ornata and Sargassum ilicifolium of alginophytes represent with relative percentage of 20 , 20 and 15 respectively which is highly useful as raw material for culture. Since the Havelock shows good alginophytic vegetation, it can be utilized for culture practices.

(vi) Car Nicobar

In an area of 334.87 ha, a total density and biomass of 409.40 ± 169.95 g/m^2 and 13710.26 ± 5689.14t are derived from the survey data of 31 species. Among these, the other algae, alginophytes and agariophytes represent the density and biomass of 290.00 ± 111.51 g/m^2 and 9711.32 ± 3732.47t; 70.58 ± 31.64g/m^2 and 2363.93 ± 1059.30 t and 48.82 ± 26.80 g/m^2 and 1635.01 ± 897.37 t respectively. The highlight of this island is that the agarophytes show

TABLE - 5

Density and Standing Crop Biomass of Seaweeds

HAVELOCK ISLAND

No	SPECIES	DENSITY g／m²		STNANDING CROP BIOMASS IN TONNES	
		Average	Sd	Average	Sd
	AGAROPHYTES				
1	*Gracilaria crassa*	13·09	7·10	553·06	414·80
2	*G. folifera*	10·39	9·78	440·96	301·36
	Total	23.48	16.88	994.02	716.16
	ALGINOPHYTES				
1	*Padina gymnospora*	35·46	14·18	1504·94	601·61
2	*P. tetrastomatica*	37·10	6·91	1574·78	293·08
3	*Sargassum wightii*	45·20	9·72	1918·42	412·36
4	*S. ilicifolium*	62·06	14·56	2634·06	617·88
5	*Turbinaria ornata*	76·98	15·20	3267·36	645·02
6	*T. conoides*	75·24	26·25	3193·28	1113·81
7	*T. turbinata*	29·56	7·97	1254·53	338·23
	Total	361.60	94.79	15347.37	4021.99
	OTHER ALGAE				
1	*Enteromorpha compressa*	5·22	2·36	221·48	100·25
2	*Ulva lactuca*	5·19	3·50	220·10	148·44
3	*Cladophora utriculosa*	2·37	1·29	100·60	54·58
4	*Chaetomorpha antenina*	8·77	4·15	372·34	176·06
5	*Caulerpa cupressoides*	4·06	1·73	172·41	73·29
6	*C. racemosa*	4·95	2·00	210·24	84·87
7	*C. taxifolia*	2·72	1·50	115·61	63·65
8	*Codium tomentosum*	3·11	1·63	131·92	69·18
9	*Dictyota dichotoma*	2·65	1·62	112·27	68·86
10	*Hydroclathrus clathratus*	5·55	2·25	235·58	95·50
11	*Amphiroa rigida*	2·93	1·66	124·30	70·52
12	*Galaxaura oblongata*	3·31	1·38	140·54	58·55
13	*Laurencia papillosa*	8·27	3·97	350·93	168·48
	Total	59.10	29.04	2508.32	1232.14
	GRAND TOTAL	420·70	140·71	18849·71	5970·29

HAVELOCK ISLAND

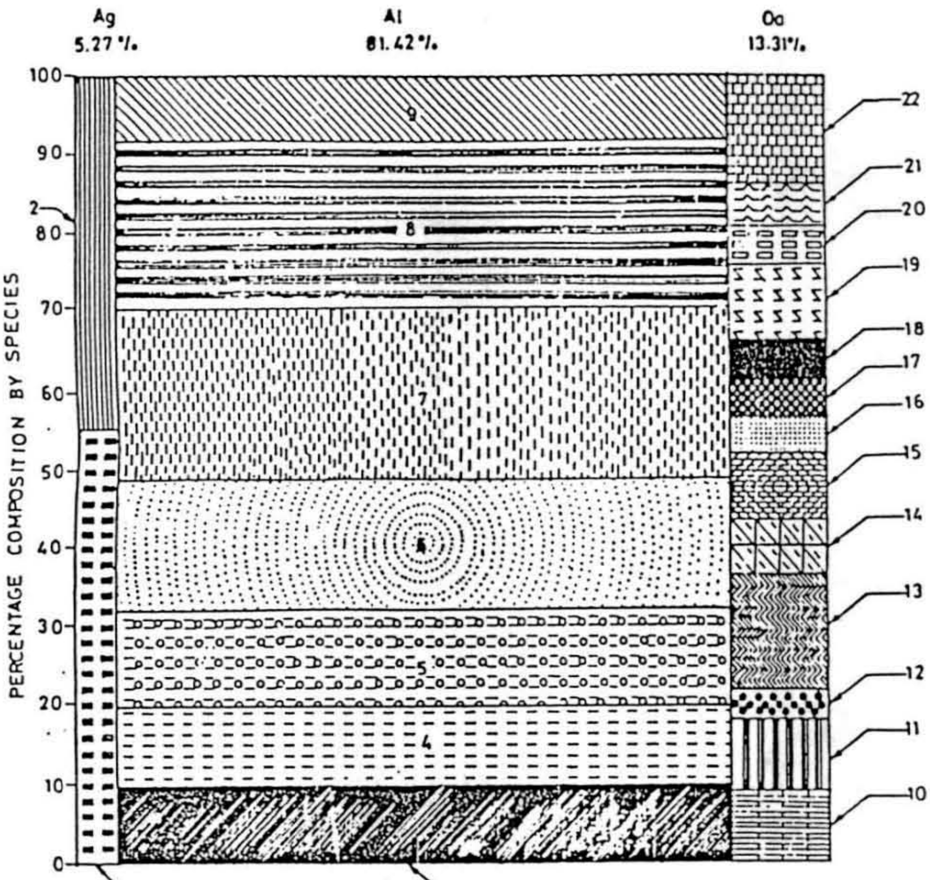


FIGURE - 14

DIVIDED RECTANGLE SHOWING PERCENTAGE OF TOTAL STANDING CROP (WEIGHT) BY MAJOR GROUP AND SPECIES COMPOSITION WITHIN EACH MAJOR GROUP

Ag - Agarophytes Al - Alginophytes Oa - Other algae

1 Gracilaria crassa
2 Gracilaria folifera
3 Padina gymnospora
4 Padina tetrastromatica
5 Sargassum wightii
6 Sargassum illicifolium
7 Turbinaria ornata
8 Turbinaria conoides
9 Turbinaria turbinata
10 Enteromorpha compressa
11 Ulva lactuca
12 Cladophora utriculosa
13 Chaetomorpha antenina
14 Caulerpa cuppresoides
15 Caulerpa racemosa
16 Caulerpa taxifolia
17 Codium tomentosum
18 Dictyota dichotoma
19 Hydroclathrus clathratus
20 Amphiroa rigida
21 Galaxaura
22 Laurencia papillosa

significant quantity, unlike the Mayabunder, Diglipur and Neil islands (Table 6). According to divided rectangle representation (Fig 15), which depicts that Car Nicobar has healthy vegetation with lot of species, which is of economical importance. Eventhough Car Nicobar is poor in population of agarophytes and alginophytes, considerable number of species of agarophytes (6 Nos.) and alginophytes (6 Nos.) are noticed and also show that these species are supressed by the other algae group. Since the availability of the agarophyte and alginophyte species is good it can be improved by doing further research. Here in Car Nicobar, the intertidal area is vast and it is always exposed during the low tide which may affect the growth of alginophytes and agarophytes, because of their sensitiveness against light. Moreover, the subtidal part which is important for agarophytes and alginophytes growth seems reduced in most of the stations due to sudden depth and currents.

Since the intertidal part has rocky and dead coral substratum, it allows many seaweeds to grow. From the divided rectangle (Fig 15) it is understood that the species of other algae group have almost equal representation. This suggests that Car Nicobar is ideal for seaweeds to grow without competition except the vast exposed lowtide part.

TABLE - 6

Density and Standing Crop Biomas of Seaweeds

CARNICOBAR ISLAND

No	SPECIES	DENSITY g / m²		STANDING CROP BIOMASS IN TONNES	
		Average	Sd	Average	Sd
	AGAROPHYTES				
1	*Gelidiella acerosa*	6·12	3·25	205·01	108·81
2	*Grcilaria edulis*	8·04	4·88	269·20	163·34
3	*G. crassa*	13·30	6·66	445·39	222·88
4	*G. folifera*	11·78	6·17	394·59	206·69
5	*G. corticata*	6·36	3·13	213·05	104·83
6	*G. indica*	3·22	2·71	107·77	90·82
	Total	48.82	26.80	1635.01	897.37
	ALGINOPHYTES				
1	*Padina gymnospora*	15·84	4·87	530·53	162·90
2	*Turbinaria ornata*	17·29	7·93	579·14	265·59
3	*T. dentata*	10·00	5·25	334·97	175·64
4	*T. conoides*	5·08	2·15	170·21	72·02
5	*Sargassum illicifolium*	14·95	7·22	500·76	241·76
6	*S. duplicatum*	7·42	4·22	248·32	141·39
	Total	70.58	31.64	2363.93	1059.30
	OTHER ALGAE				
1	*Schizomeris leibleinii*	2·64	1·76	88·25	58·91
2	*Enteromorpha compressa*	35·92	14·59	1202·96	488·42
3	*Ulva lactuca*	25·67	9·78	859·60	327·41
4	*U. reticulata*	12·22	5·20	409·05	174·05
5	*Chaetomorpha antennina*	9·99	4·81	334·55	161·08
6	*Caulerpa racemosa*	9·61	5·14	321·72	172·18
7	*Halimeda incrassata*	38·72	9·23	1276·54	308·91
8	*H. peltata*	20·14	5·98	674·54	200·01
9	*H. discoidea*	17·90	7·19	599·33	240·61
10	*Chondrus crispus*	12·32	5·78	412·63	193·50
11	*Liagora ceranoides*	12·31	4·78	412·23	159·98
12	*Galaxaura oblongata*	12·69	5·70	424·90	190·92
13	*Amphiroa fragillissima*	19·56	6·37	655·13	213·34
14	*Laurancia papillosa*	8·64	4·67	289·35	156·24
15	*Valonia sp*	4·64	3·46	155·43	115·63
16	*Acanthophora spicifera*	27·89	7·74	933·97	258·97
17	*Dictyota dichotoma*	4·45	2·09	149·04	69·84
18	*Grateloupia lithophila*	3·19	1·43	106·94	47·83
19	*Hypnea muciformis*	11·50	5·81	385·16	194·64
	Total	290.00	111.51	9711.32	3732.47
	GRAND TOTAL	409·40	169·95	13710·26	5689·14

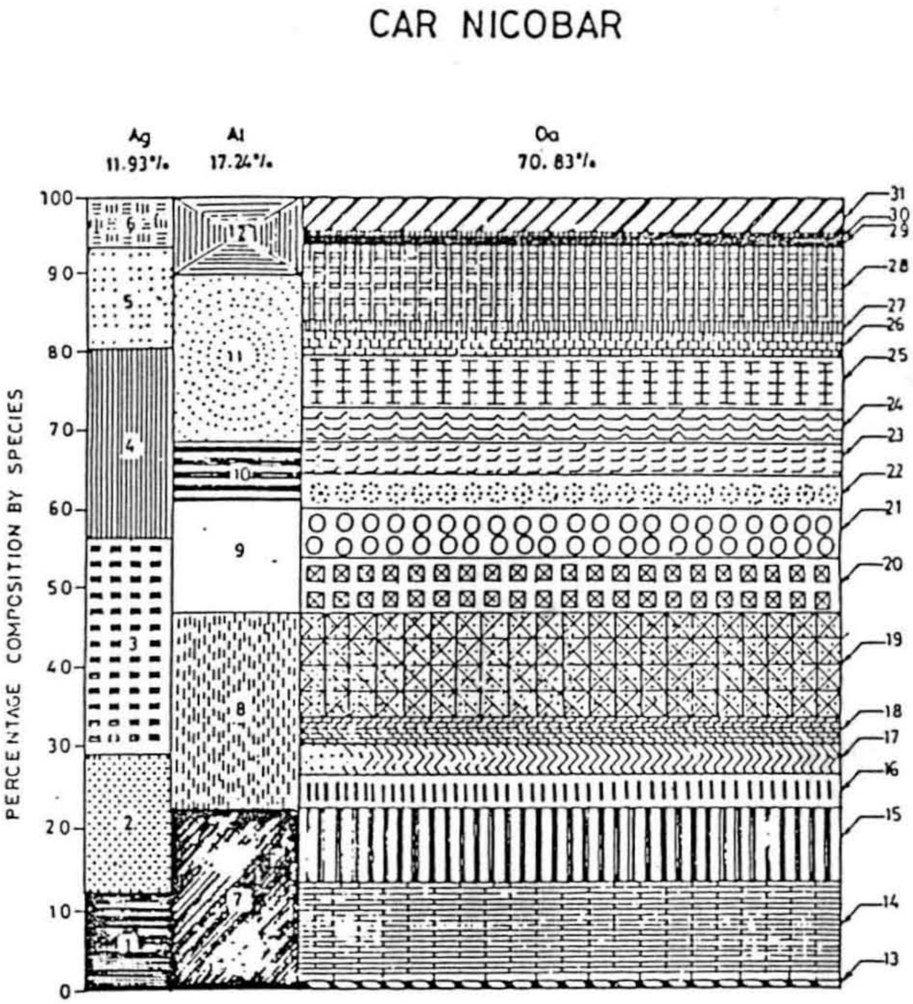


FIGURE - 15

DIVIDED RECTANGLE SHOWING PERCENTAGE OF TOTAL STANDING CROP (WEIGHT) BY MAJOR GROUP AND SPECIES COMPOSITION WITHIN EACH MAJOR GROUP

Ag - Agarophytes   Al - Alginophytes   Oa - Other algae

1	Gelidiella acerosa	17	Chaetomorpha antennina
2	Gracilaria edulis	18	Caulerpa racemosa
3	Gracilaria crassa	19	Halimeda incrassata
4	Gracilaria foliifera	20	Halimeda peltata
5	Gracilaria corticata	21	Halimeda discoidea
6	Gelidiella indica	22	Chondrus crispus
7	Padina gymnospora	23	Liagora ceranoides
8	Turbinaria ornata	24	Galaxaura oblangata
9	Turbinaria dentata	25	Amphiroa fragillasima
10	Turbinaria conoides	26	Laurencia papillosa
11	Sargassum illicifolium	27	Valonia sp
12	Sargassum duplicatum	28	Acanthophora spicifera
13	Schizomeris leiblanii	29	Dictyota dichotoma
14	Enteromorpha compressa	30	Grateloupia lithophila
15	Ulva lactuca	31	Hypnea musciformis
16	Ulva reticulata		

(vii) Chowra

In this island a total amount of density and biomass for 21 species are 417.12 $\pm$ 157.23 g/m^2 and 4135.71 $\pm$ 1558.21 t for the area of 99.15 ha.(Table 8) The respective density and biomass of agarophytes, alginophytes and other algae groups are 89.63 $\pm$ 32.53 g/m^2 and 888.64 $\pm$ 322.44 t; 134.34 $\pm$ 46.07 and 1331.99 $\pm$ 456.48 t and 193.15 $\pm$ 78.63 and 1915.08 $\pm$ 779.29t. Among agarophytes *Gracilaria edulis* shows an average density of 25.88 $\pm$ 8.36 g/m^2 and *Gracilaria corticata* shows 34.31$\pm$ 12.08 g/m^2. Compared to Car Nicobar, in Chowra the intertidal part has vast area but because of currents, vegetation is restricted. The divided rectangle shows better vegetation of agarophytes, the relative values are 21.49% for agarophytes, 32.20% alginophytes, and other algae 46.31%. (Fig. 17)

(viii) Terassa

Terassa island exhibits a total density and biomass of 314.85 $\pm$ 180.61 g/m^2, and 5047.11 $\pm$ 2603.47t in an area of 160.30 ha. Eventhough the island has vast shoreline, the subtidal area is totally supressed, and that may be the reason for less quantity of seaweeds distribution. Here the other algae group with 8 number of species shows a density and biomass of 184.65 $\pm$ 113.34 g/m^2

TABLE - 8

Density and Standing Crop Biomass of Seaweeds

CHOWRA ISLAND

No	SPECIES	DENSITY g/m²		STANDING CROP BIOMASS IN TONNES	
		Average	Sd	Average	Sd
	AGAROPHYTES				
1	*Gracilaria edulis*	25·88	8·36	256·62	82·86
2	*G. corticata*	34·31	12·08	340·17	119·75
3	*Gelidiella acerosa*	20·12	7·05	199·47	69·92
4	*Gelidium rigidum*	9·32	5·04	92·38	49·91
	TotaL	89.63	32.53	888.64	322.44
	ALGINOPHYTES				
1	*Padina gymnospora*	10·28	3·60	101·88	35·64
2	*P. tetrastomatica*	21·12	5·53	209·37	54·80
3	*Sargassum ilicifolium*	27·48	8·43	272·46	83·53
4	*S. wightii*	15·53	5·42	153·97	53·67
5	*Turbinaria ornata*	26·88	8·65	266·54	85·75
6	*T. turbinata*	13·47	7·04	133·59	69·77
7	*T. dentata*	19·58	7·40	194·18	73·32
	Total	134.34	46.07	1331.99	456.48
	OTHER ALGAE				
1	*Enteromorpha compressa*	19·82	9·64	196·52	95·58
2	*Caulerpa taxifolia*	16·33	6·33	161·94	62·75
3	*Ulva lactuca*	16·14	4·85	160·03	48·03
4	*Laurencia papillosa*	23·33	5·52	231·12	54·73
5	*Amphiroa fragillissima*	20·51	5·75	203·39	56·94
6	*Lithophyllum sp.*	15·63	4·53	154·94	44·85
7	*Halimeda peltata*	9·64	5·66	95·55	56·05
8	*H. incrassata*	36·23	11·94	359·26	118·37
9	*Acanthophora spicifera*	15·87	6·57	157·35	65·10
10	*Valonia sp.*	19·67	17·84	194·98	176·89
	Total	193.15	78.63	1915.08	779.29
	GRAND TOTAL	417·12	157·23	4135·71	1558·21

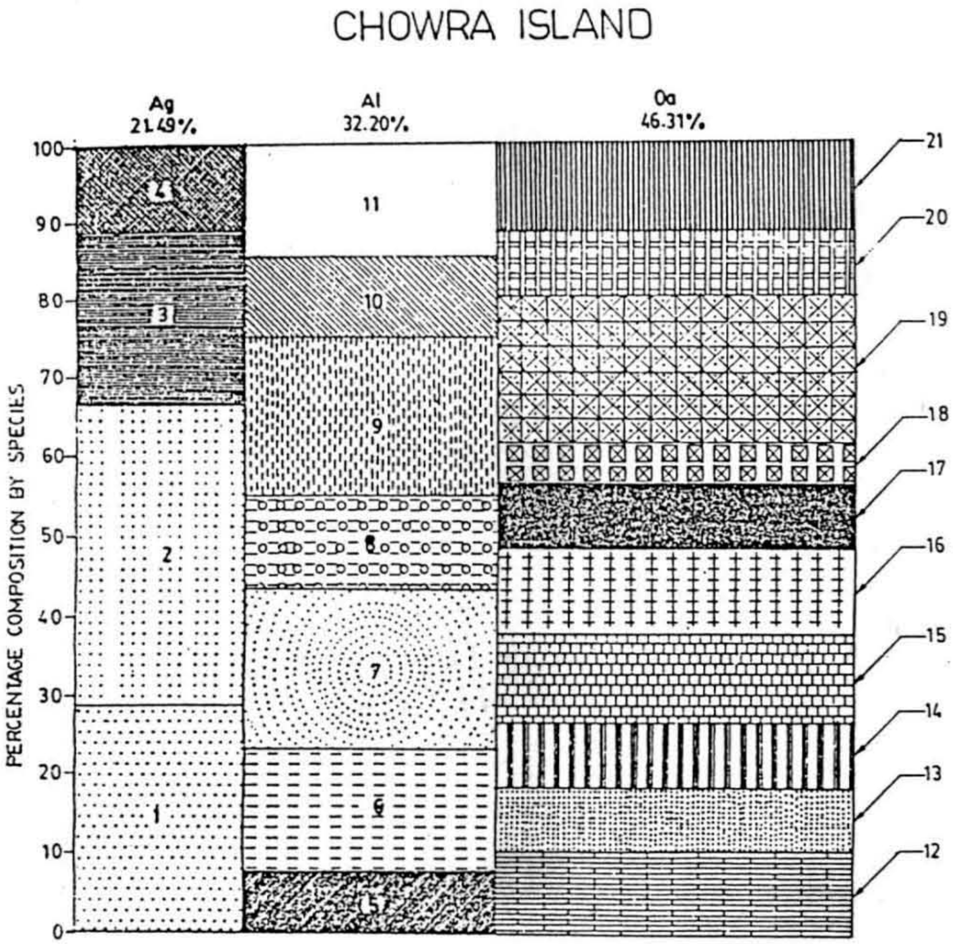


FIGURE - 17

DIVIDED RECTANGLE SHOWING PERCENTAGE OF TOTAL STANDING CROP(WEIGHT) BY MAJOR GROUP AND SPECIES COMPOSITION WITHIN EACH MAJOR GROUP

Ag - Agarophytes Al - Alginophytes Oa - Other algae

1 Gracilaria edulis
2 Gracilaria corticata
3 Gelidiella acerosa
4 Gelidium rigidum
5 Padina gymnospora
6 Padina tetrastromatica
7 Sargassum illicifolium
8 Sargassum wightii
9 Turbinaria ornata
10 Turbinaria turbinata
11 Turbinaria dentata
12 Enteromorpha compressa
13 Caulerpa sp.
14 Ulva lactuca
15 Laurencia papillosa
16 Amphiroa fragillesima
17 Lithophyllum sp.
18 Halimeda peltata
19 Halimeda incrassata
20 Acanthophora spicifera
21 Valonia sp.

and 2959.96 $\pm$ 1389.48t respectively and followed by alginophytes with 106.55 $\pm$ 48.42 g/m^2 and 1707.96 $\pm$ 945.46t and agarophytes with 23.65 $\pm$ 18.85g/m^2 and 379.19 $\pm$ 268.53t (Table 7). From the divided rectangle (Fig. 16) which exhibits the percentage of other algae with 58.65 followed by alginophytes with 33.84 and agarophytes with 7.51 illustrate that here also all species have their own individual representtion in their respective groups.

(ix) Bumpoka Island

From Bumpoka overall density and biomass of 265.64 $\pm$ 127.81 $g/m^2$and 1741.08 $\pm$ 882.91t has been derived from the survey data of 20 species in an area of 65.54 ha. The recorded density values for agarophytes, alginophytes and other algae are 12.59 $\pm$ 5.41g/m^2; 122.58 $\pm$ 47.05 g/m^2 and 130.47 $\pm$ 75.35 g/m^2 respectively (Table 9). The standing crop biomass exhibits with almost equal values for alginophytes and other algae viz. 803.48$\pm$ 388.68 tonnes and 855.09 $\pm$ 457.70 t. But the agarophytes show very less quantity of 82.51 $\pm$ 36.56t. The divided rectangle shows a low percentage for agarophytes (4.74) but the alginophytes (46.15) and other algae (49.11) show almost equal percentage. (Fig. 18)

TABLE - 7

Density and Standing Crop Biomass of Seaweeds

TERASSA ISLAND

No	SPECIES	DENSITY g/m²		STANDING CROP BIMASS IN TONNES	
		AVERAGE	Sd	AVERAGE	Sd
	AGAROPHYTES				
1	*Gracilaria edulis*	18·16	15·42	291·18	227·19
2	*G. corticata*	5·49	3·43	88·01	41·34
	Total	23.65	18.85	379.19	268.53
	ALGINOPHYTES				
1	*Padina gymnospora*	36·54	13·05	585·72	312·43
2	*Turbinaria turbinata*	21·23	8·71	340·36	193·31
3	*T. conoides*	9·63	4·87	154·30	94·41
4	*Sargassum illicifolium*	39·15	21·79	627·58	345·31
	Total	106.55	48.42	1707.96	945.46
	OTHER ALGAE				
1	*Enteromorpha compressa*	9·35	3·36	149·86	53·76
2	*Ulva lactuca*	5·72	2·53	91·76	45·88
3	*Caulerpa peltata*	6·84	2·92	109·72	54·86
4	*Halimeda incrassata*	43·64	30·08	699·50	341·32
5	*H. peltata*	36·06	17·79	577·99	272·49
6	*Amphiroa rigida*	11·90	6·47	190·73	140·32
7	*Laurencia papillosa*	50·04	42·40	802·21	349·46
8	*Acanthophora spicifera*	21·10	7·79	338·19	131·39
	Total	184.65	113.34	2959.96	1389.48
	GRAND TOTAL	314·85	180·61	5047·11	2603·47

TERASA ISLAND

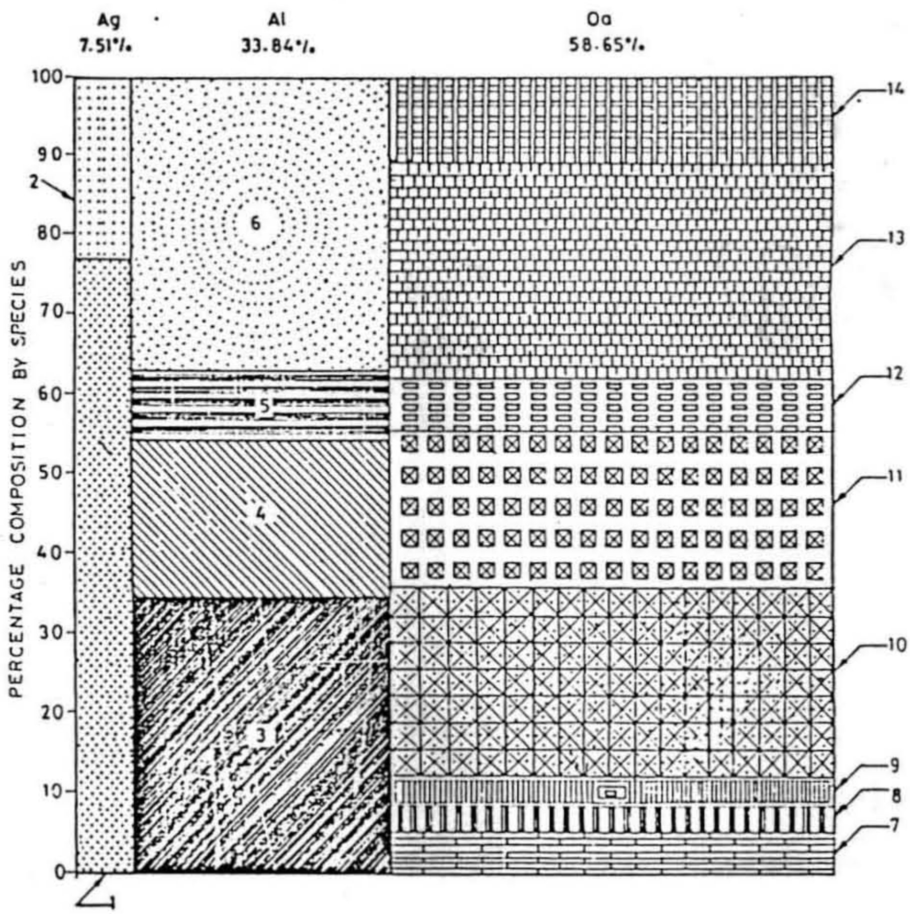


FIGURE - 16

DIVIDED RECTANGLE SHOWING PERCENTAGE OF TOTAL STANDING CROP (WEIGHT) BY MAJOR GROUP AND SPECIES COMPOSITION WITHIN EACH MAJOR GROUP

Ag – Agarophytes Al – Alginophytes Oa – Other algae

1	Gracilaria edulis	8	Ulva lactuca
2	Gracilaria corticata	9	Caulerpa peltata
3	Padina gymnospora	10	Halimeda incrassata
4	Turbinaria turbinata	11	Halimeda peltata
5	Turbinaria conoides	12	Amphiroa rigida
6	Sargassum illicifolium	13	Laurencia papillosa
7	Enteromorpha compressa	14	Acanthophora spicifera

TABLE - 9

Density and Standing Crop biomass of Seaweeds

BUMPOKA ISLAND

No	SPECIES	DENSITY g/m²		STANDING CROP BIOMASS IN TONNES	
		Average	Sd	Average	Sd
	AGAROPHYTES				
1	*Gelidiella acerosa*	5·83	3·07	38·22	16·34
2	*Gracilaria edulis*	6·76	2·34	44·29	20·19
	Total	12.59	5.41	82.51	36.53
	ALGINOPHYTES				
1	*Padina tetrastomatica*	20·13	7·13	131·95	84·31
2	*P. gymnospora*	12·47	5·24	81·73	41·48
3	*Turbinaria turbinata*	47·48	13·82	311·84	110·49
4	*T. conoides*	13·20	7·38	86·54	39·38
5	*Sargassum ilicifolium*	20·54	8·71	134·63	71·63
6	*S. wightii*	8·66	4·47	56·79	41·39
	Total	122.58	47.05	803.48	388.68
	OTHER ALGAE				
1	*Enteromorpha compressa*	11·50	8·34	75·37	41·72
2	*Chaetomorpha antennina*	6·51	3·14	42·66	13·79
3	*Ulva lactuca*	4·66	2·13	30·52	16·43
4	*Caulerpa racemosa*	3·44	1·08	22·56	11·69
5	*C. peltata*	1·33	0·92	8·74	4·73
6	*Laurencia papillosa*	3·61	1·31	23·64	16·79
7	*Halimeda incrassata*	21·73	14·49	142·42	81·64
8	*H. opuntia*	15·42	12·31	101·08	93·31
9	*Amphiroa fragillissima*	17·88	6·78	117·18	89·34
10	*Acanthophora spicifera*	7·24	3·93	47·47	12·91
11	*Lithiphyllum sp.*	15·17	12·14	99·42	33·64
12	*Hypnea muciformis*	21·98	8·78	144·03	41·71
	Total	130.47	75.35	855.09	457.70
	GRAND TOTAL	265·64	127·81	1741·08	882·91

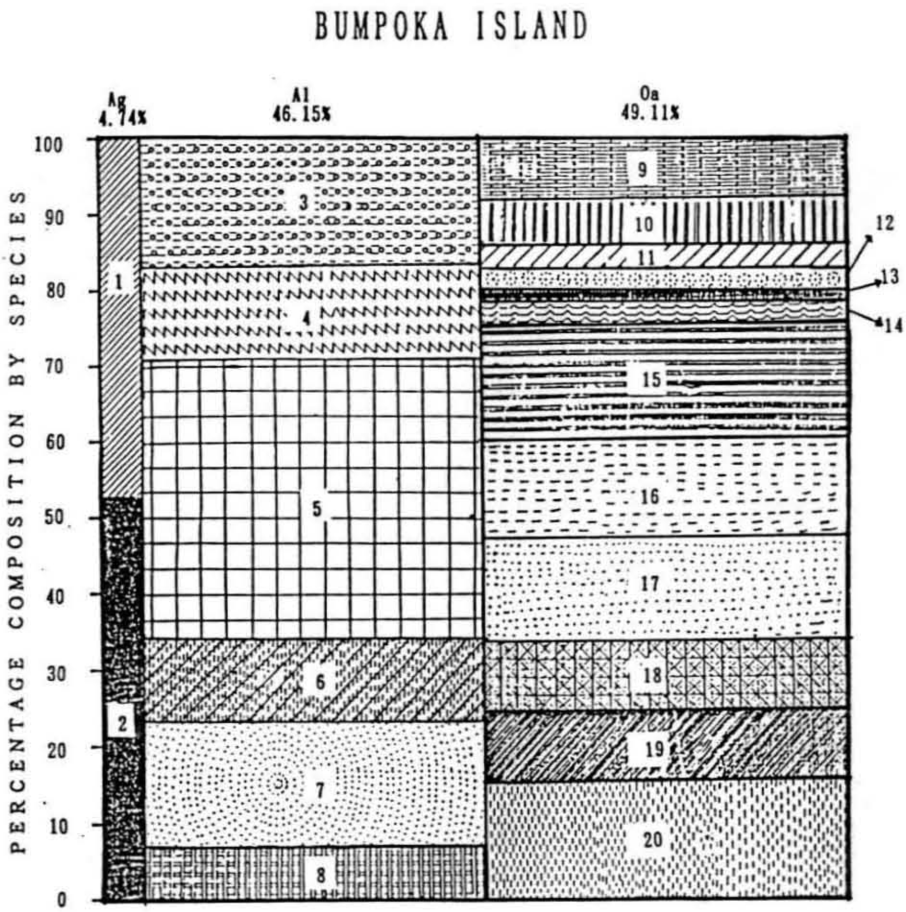


FIGURE - 18
DIVIDED RECTANGLE SHOWING PERCENTAGE OF TOTAL STANDING CROP (WEIGHT) BY MAJOR GROUP AND SPECIES COMPOSITION WITHIN EACH MAJOR GROUP

1. Gelidiella acerosa
2. Gracilaria edulis
3. Padina tetrastomatica
4. P. gymnospora
5. Turbinaria turbinata
6. T. conoides
7. Sargassum ilicifolium
8. S. wightii
9. Enteromorpha compressa
10. Chaetomorpha antennina
11. Ulva lactuca
12. Caulerpa racemosa
13. C. peltata
14. Laurencia papilosa
15. Halimeda incrassata
16. H. opuntia
17. Amphiroa fragillissima
18. Acanthophora spicifera
19. Lithophyllum sp.
20. Hypnea musciformis

B. Comparative position of agarophytes, alginophytes and other algae in the surveyed islands

A total seaweed density of 3318.8 ± 1331.78 g/m^2 has been derived for the nine islands, in which the agarophytes, alginophytes and other algae represent 260.51 ± 136.89 g/m^2; 1655.46 ± 579.88 g/m^2; 1426.61 ± 615.01 g/m^2 respectively. The alginophytes show overall dominance (Table 10). The agarophytes show maximum densities of 89.63 ± 32.53 g/m^2 from Chowra. The alginophytes show over all dominance with maximum density of 361.60 ± 94.79 g/m^2 from Havelock and in over all they have good vegetation, but in Nicobar group they have been slightly suppressed.

Considering standing crop biomass in a total area of 2227.02 ha (9 islands) the estimated value is 85124.57 ± 33401.06 tonnes, in which the alginophytes exhibit with high values of 44590.22 ± 15757.2 t and the agarophytes with only 7055.32 ± 3563.37 t (Table 11). The standing crop biomass of Chowra and Car Nicobar show better values for agarophytes and the alginophytes with overall dominance. From this point of view it can be assumed that the volcanic oriented soil of Andaman group supports for alginophytes, the coral oriented Nicobar group supports for agarophytes better than alginophytes.

TABLE - 10

COMPARATIVE POSITION OF SEAWEEDS IN DENSITY

No	ISLANDS	AGAROPHYTES		ALGINOPHYTES		OTHER ALGAE		TOTAL	
		Average Density g / m²	Standard Deviation	Average Density g / m²	Standard Deviation	Average Density g / m²	Standard Deviation	Average Density g / m²	Standard Deviation
1	South Andaman	32.35	16.27	365.57	145.15	221.75	85.65	619.67	247.07
2	Mayabunder (MIDDLE ANDAMAN)	--	--	113.18	50.90	37.88	15.21	151.06	66.11
3	Diglipur (NORTH ANDAMAN)	--	--	110.65	17.11	27.88	11.64	138.53	28.75
4	Neil	29.99	20.15	270.41	98.75	281.73	94.64	582.13	213.54
5	Havelock	23.48	16.88	361.60	94.79	59.10	29.04	420.70	140.71
6	Car Nicobar	48.82	26.80	70.58	31.64	290.00	111.51	409.10	169.95
7	Chowra	89.63	32.53	134.34	46.07	193.15	78.63	417.12	157.23
8	Terassa	23.65	18.85	106.55	48.42	184.65	113.34	314.85	180.61
9	Bumpoka	12.59	5.41	122.58	47.05	130.47	75.35	264.64	127.81
	T O T A L	260.51	136.89	1655.46	579.88	1426.61	615.01	3318.80	1331.78

TABLE - 11

COMPARATIVE POSITION OF SEAWEEDS IN STANDING CROP BIOMASS (WET WEIGHT)

No.	ISLANDS	AGAROPHYTES		ALGINOPHYTES		OTHER ALGAE		TOTAL		AREA
		Average in Tonnes	Sd	Average in Tonnes	Sd	Average in Tonnes	Sd	Average in Tonnes	Sd	IN HECTARE
1	South Andaman	2266.39	778.67	10458.97	4191.90	6385.32	3176.03	19110.68	8146.60	401.00
2	Mayabunder. (MIDDLE ANDAMAN)	--	--	2536.18	1140.25	848.60	340.46	3384.78	1480.71	224.06
3	Diglipur (NORTH ANDAMAN)	--	--	2471.43	1188.15	690.88	419.45	3432.31	1607.60	247.77
4	Neil	809.56	543.67	7298.91	2364.99	7604.46	2553.47	15712.93	5462.13	269.91
5	Havelock	994.02	716.16	15347.37	4021.99	2508.32	1232.14	18849.71	5970.29	424.42
6	Car-Nicobar	1635.01	897.37	2363.93	1059.30	9711.32	3732.47	13710.26	5689.14	334.87
7	Chowra	888.64	322.44	1331.99	456.48	1915.08	779.29	4135.71	1558.21	99.15
8	Terassa	379.19	268.53	1707.96	945.46	2959.96	1389.48	5047.11	2603.47	160.30
9	Bumpoka	82.51	36.53	803.48	388.68	855.09	457.70	1741.08	882.91	65.54
	T O T A L	7055.32	3563.37	44590.22	15757.20	33479.03	14080.49	85124.57	33401.06	2227.02

4.3 Model

The results obtained from the data of South Andaman which are collected from five fixed stations fortnightly for the purpose of modelling and system analysis are presented in three levels according to the model flow.

In the first level the results of population characters like frequency, abundance, density, coverage, dominance, population size and distribution are included. Relative frequency, relative cover and relative density are considered as important value indices to understand the deviation of the three main groups (OA, AL, AG) of seaweed community in different seasons.

The second level of results expresses the community composition in the form of diversity studies and community comparison in the form of similarity studies.

In third level, the system with environment has been analysed with help of multiple regression analysis and hierarchical cluster analysis. The results of multiple regression are presented to show significant relationship in the form of positive or negative correlation between the forcing factors and the seaweeds. Here the forcing factors (Environmental parameters) are considered as independent variables and the seaweeds which are affected (positively and negatively) by environmental factors are considered as dependant variables.

4.3.1 <u>POPULATION LEVEL</u>

Data obtained fortnightly for 20 months from August '88 to March '90 on individuals, biomass in freshweight and coverage of seaweeds are used to obtain the results for the above said population parameters and the results are expressed for 5 stations with two parts (Intertidal and subtidal) in three different seasons (monsoon, premonsoon and postmonsoon) are shown in the Tables (12a-17c)

The three different seasons (monsoon, premonsoon and post monsoon) are separated based on the salinity trend (1) a period of high salinity with very little fluctuation during February to April, the Pre-South West monsoon period, (2) a fairly long period of comparatively low salinity with greater fluctuations during May to November, the period of the two monsoons and (3) a period of recovery during December and January, the Post-North East monsoon period. A total number of 35 species are considered and analysed in detail.

(i) <u>Frequency distribution</u>

Seasonwise degree of dispersion of individual seaweed species in 5 stations are expressed in the form of percentage frequency (Table 12a, b, c). Almost in all stations the monsoon and postmonsoon show high percentage of frequency. Eventhough the salinity is low during the monsoon period, the seaweed shows good frequencies from the last three months of monsoon and postmonsoon period. Since premonsoon period has the initial growing stage for most of the seaweeds, it should have got more percentage frequency, but here the species are ment to grow in cluster even large number of species could cover only few quadrats.

From the table of percentage frequency, it can be understood that the species of seral community have the main dominant flow in all the stations as well as in the intertidal and subtidal parts. The Halimeda spp - (70%, 80%, 60%) (60%, 30%, 100%) (50%, 60%, 70%) (60%, 80%, 100%) (70%, 80%, 60%) (50%, 90%, 60%) (60%, 60%, 70%) (70%, 60%, 80%,) (50%, 60%, 60%,) (40%, 60%, 100%) has the more frequencies in all the 5 stations in intertidal as well as in the subtidal part in all three seasons and like this in the intertidal part the species Enteromorpha compressa (40%, 80%, 60%,) (50%, 40%, 80%,) (40%, 40%, 60%) represents with some what good frequencies in all three seasons. In the subtidal part the species Padina gymnospora has the value of (40%, 90%, 40%,) (50%, 60%, 30%,) (30%, 70%, 30%,) (40%, 60%, 20%,) (40%, 30%, 30%). In general, almost all climax species have better frequencies, on the other hand in the

TABLE - 12 a

SEASONWISE FREQUENCY (IN %) DISTRIBUTION OF SEAWEEDS IN DIFFERENT SYSTEMS (STATIONS).

Sl. No.	SPECIES	STATION-1						STATION-2					
		INTERTIDAL			SUBTIDAL			INTERTIDAL			SUBTIDAL		
		Pre-Mon.	Mon.	Post-Mon.	Pre-Mon.	Mon.	Post-Mon.	Pre-Mon.	Mon.	Post-Mon.	Pre-Mon.	Mon.	Post Mon
1	(OA) *Enteromorpha compressa*	40	80	60									
2	*Ulva spp.*		50	40									
3	*Chaetomorpha antennina*			20					60	40			
4	*Cladophora marina*												
5	*Caulerpa spp.*	40	50	40				40	70	60			
6	*Acetabularia calyculus*		70	50					80	40			
7	*Codium spp.*	20	60	20	20	20	40	30	40	60	30	70	50
8	*Halimeda spp.*	70	80	60	60	30	100	50	60	70	60	80	100
9	*Valoniopsis pachynema*					60	50					60	70
10	*Ectocarpus siliculosus*							40	50				
11	*Dictyota dichotoma*		60	50		70	70		60			10	40
12	*Hydroclathrus clathratus*												
13	*Amphiroa spp.*				40	60	40				30	70	60
14	*Jania rubens*					30	60						
15	*Grateloupia spp.*										50	20	70
16	*Hypnea spp.*								40	20		40	60
17	*Galaxaura oblongata*							50		50			
18	*Ceramium avalona*								60	40			
19	*Laurencia papilosa*												
20	(AL) *Padina tetrastomatica*												
21	*P. gymnospora*	30	30	50	40	90	40	40	40	30	50	60	30
22	*Sargassum ilicifolium*	20	30	60	30	40	60	30	20	30	40	80	40
23	*S. myriosystem*												
24	*S. duplicatum*												
25	*S. tennerium*		40			60	70						
26	*S. wightii*	20	70	50	30	30	60	10	80	20	40	40	20
27	*Turbinaria conoides*	30	80	60	20	60	40	30	60	50	20	60	60
28	*T. ornata*	30	50	40	30	10	70	30	70	30	10	40	40
29	*T. turbinata*				20				80	50			
30	(AG) *Gelidium heteroplatus*			20	20	30	10	20	40	30	30	20	50
31	*Gelidiella acerosa*		30	30			40						
32	*Gracilaria corticata*					60							
33	*G. crassa*												
34	*G. edulis*												
35	*G. folifera*												
	TOTAL	300	780	650	310	650	750	370	910	620	360	650	690

TABLE - 12b

SEASONWISE FREQUENY (IN %) DISTRIBUTION OF SEAWEEDS IN DIFFERENT SYSTEMS (STATIONS).

Sl. No.	SPECIES	STATION-3						STATION-4					
		INTERTIDAL			SUBTIDAL			INTERTIDAL			SUBTIDAL		
		Pre-Mon.	Mon.	Post-Mon.	Pre-Mon.	Mon.	Post-Mon.	Pre-Mon.	Mon.	Post-Mon.	Pre-Mon.	Mon.	Post-Mon
1	(OA)*Enteromorpha compressa*	50	40	80				40	40	60			
2	*Ulva spp.*		50	60					40	40			
3	*Chaetomorpha antennina*								30	50			
4	*Cladophora marina*							50					
5	*Caulerpa spp.*	50	80	30									
6	*Acetabularia calyculus*		60	40									
7	*Codium spp.*							20	70	30	30	40	40
8	*Halimeda spp.*	70	80	60	50	90	60	60	60	70	70	60	80
9	*Valoniopsis pachynema*			10									
10	*Ectocarpus siliculosus*							40	50				
11	*Dictyota dichotoma*		30										
12	*Hydroclathrus clathratus*					40	30					60	70
13	*Amphiroa spp.*				30	50	30				40	60	80
14	*Jania rubens*		40	90		40	40		40	20		40	60
15	*Grateloupia spp.*				20	30					40	30	
16	*Hypnea spp.*		60	60		50	30						
17	*Galaxaura oblongata*	40	70										
18	*Ceramium avalona*								40	30			60
19	*Laurencia papilosa*	30	60	50				30	40	50	40	10	
20	(AL)*Padina tetrastomatica*		60	70		40	80		30	60		100	90
21	*P. gymnospora*	50	20	40	30	70	30	40	40	80	40	60	20
22	*Sargassum ilicifolium*	20	30	60	20	50	20	30	30	10	60	70	60
23	*S. myriosystem*	20	30	70	30	40	40	50	10	30	30	30	30
24	*S. duplicatum*					20	20			50			100
25	*S. tennerium*					30							
26	*S. wightii*	30	60	100	30	40	70	40	30	50	20	50	30
27	*Turbinaria conoides*	20	60	80	20	40	60						
28	*T. ornata*	20	30	40	20	80	30						
29	*T. turbinata*			30		30	20		40	40		70	20
30	(AG)*Gelidium heteroplatus*		60					20	40	40		20	
31	*Gelidiella acerosa*								50	30		10	60
32	*Gracilaria corticata*							20	60	30	40	40	90
33	*G. crassa*				20	70	10				20	20	40
34	*G. edulis*									80			20
35	*G. folifera*									60			40
	T O T A L	400	920	970	270	810	570	440	740	910	430	770	990

TABLE - 12c

SEASONWISE FREQUENCY (IN %) DISTRIBUTION OF SEAWEEDS IN DIFFERENT SYSTEMS (STATIONS).

Sl. No.	SPECIES	STATION-5					
		INTERTIDAL			SUBTIDAL		
		Pre-Mon.	Mon.	Post-Mon.	Pre-Mon.	Mon.	Post-Mon.
1	(OA)*Enteromorpha compressa*						
2	*Ulva spp.*						
3	*Chaetomorpha antennina*						
4	*Cladophora marina*	20		90			60
5	*Caulerpa spp.*		30				
6	*Acetabularia calyculus*						
7	*Codium spp.*						
8	*Halimeda spp.*	50	60	60	40	60	100
9	*Valoniopsis pachynema*		70	70		30	90
10	*Ectocarpus siliculosus*	50	20		40		
11	*Dictyota dichotoma*		90	60		50	40
12	*Hydroclathrus clathratus*			60		30	30
13	*Amphiroa spp.*				40	60	60
14	*Jania rubens*		60	60		50	50
15	*Grateloupia spp.*						
16	*Hypnea spp.*		60	20		20	30
17	*Galaxaura oblongata*						
18	*Ceramium avalona*		40	60			60
19	*Laurencia papilosa*	40	60	50	50	100	40
20	(AL)*Padina tetrastomatica*		10	30		100	80
21	*P. gymnospora*	30	60	20	40	30	30
22	*Sargassum ilicifolium*	40	70	70	30	40	30
23	*S. myriosystem*	20	70		20	20	
24	*S. duplicatum*			40			
25	*S. tennerium*						
26	*S. wightii*	40	40	70	80	20	70
27	*Turbinaria conoides*	30	30	70	30	10	60
28	*T. ornata*	40	30	40	50	80	20
29	*T. turbinata*						
30	(AG)*Gelidium heteroplatus*						
31	*Gelidiella acerosa*		60	30		30	90
32	*Gracilaria corticata*	30	40	10	50	10	60
33	*G. crassa*			70	30	30	30
34	*G. edulis*			80			40
35	*G. folifera*			30			30
	T O T A L	390	900	1090	500	770	1100

seral species, eventhough their life is reduced in one period they have their own percentage frequency in one or two seasons. The species Cladophora marina in station 5 shows 90% and 60% in both tidal parts during postmonsoon period. Like this, species Padina tetrastomatica has maximum percentage frequency of 100 in the monsoon period in the subtidal part of the station No.5. From the result, the fluctuation may be concluded that the availability of climax community in all the three seasons must be nearly to random level are the possible reason to have good distribution in all seasons.

The species like Codium spp., Halimeda spp., Padina tetrastomatica, Sargassum ilicifolium, S. wightii, Turbinaria conoides, and T. ornata show better distribution during three seasons and in both intertidal and subtidal parts. The species Enteromorpha compressa and Caulerpa spp. show better distribution only in the intertidal part. The species like Amphiroa spp., Grateloupia spp. and Gelidium heteroplatus show better distribution in the subtidal part and these are the only species available throughout the year.

To know the real numerical strength of the species in its distributed area, seasonwise abundance in number are presented in table 13a. Here the original areas of study

(Quadrat) are not taken into account, and only the species available are taken into consideration. In that area, numerical strength of the individual species are presented in the maximum relative frequency at 10% in any one of the season in both subtidal and intertidal parts. The species like Halimeda spp. and Padina gymnospora exhibit above 10% relative frequency in any one of the seasons in both tidal parts, and the species like Enteromorpha compressa, Acetabularia calyculus, Padina tetrastomatica, Sargassum tennerium, and Turbinaria conoides show above 10% in subtial part.

ii) **Abundance**

Table 13a, b and c list the abundance of all species recorded at all stations in both tidal parts. In general, the majority of the seaweed species at any particular sampling location (Station) are widely distributed, eventhough at some of the stations they may have low abundance. Evaluating species abundance with respect to the 3 major seasons, this trend is more apparent. In fact the subtidal and intertidal parts of each station in different seasons have a distinct group of species generally restricted to the zone with common species for both tidal parts. There is an increase in the number of species

TABLE - 13 a

SEASONWISE ABUNDANCE (IN NUMBER) OF SEAWEEDS IN DIFFERENT SYSTEMS (STATIONS).

Sl. No.	SPECIES	STATION-1						STATION-2					
		INTERTIDAL			SUBTIDAL			INTERTIDAL			SUBTIDAL		
		Pre-Mon.	Mon.	Post-Mon.	Pre-Mon.	Mon.	Post-Mon.	Pre-Mon.	Mon.	Post-Mon.	Pre-Mon.	Mon.	Post-Mon
1	(OA)*Enteromorpha compressa*	29	16	41									
2	*Ulva spp.*	3		7									
3	*Chaetomorpha antennina*			26					3	12			
4	*Cladophora marina*												
5	*Caulerpa spp.*	5	4	5				8	6	4			
6	*Acetabularia calyculus*		12	30					12	30			
7	*Codium spp.*	6	5	6	5	4	4	5	3	3	7	4	4
8	*Halimeda spp.*	12	8	14	14	5	3	19	16	4	15	5	8
9	*Valoniopsis pachynema*	5				6	16			2			6
10	*Ectocarpus siliculosus*							10	10				
11	*Dictyota dichotoma*		4	5		3	1		2			4	5
12	*Hydroclathrus clathratus*												
13	*Amphiroa spp.*				6	5	8				3	4	7
14	*Jania rubens*					14	9						
15	*Grateloupia spp.*										4	6	3
16	*Hypnea spp.*								5	6		5	1
17	*Galaxaura oblongata*							4		2			
18	*Ceramium avalona*								2	4			
19	*Laurencia papilosa*												
20	(AL)*Padina tetrastomatica*												
21	*P. gymnospora*	11	5	7	10	3	4	8	5	6	10	3	3
22	*Sargassum ilicifolium*	6	7	4	6	7	3	5	4	10	4	4	2
23	*S. myriosystem*												
24	*S. duplicatum*											6	10
25	*S. tennerium*		15			5	4					5	
26	*S. wightii*	6	6	8	3	4	8	13	5	4	3	3	27
27	*Turbinaria conoides*	4	8	4	8	3	5	5	25	5	5	3	5
28	*T. ornata*	6	6	7	8	4	6	7	7	3	8	7	4
29	*T. turbinata*				11				5	7			
30	(AG)*Gelidium heteroplatus*			20	16	5	4	18	5	7	10	8	6
31	*Gelidiella acerosa*		3	5			5						
32	*Gracilaria corticata*					7							
33	*G. crassa*												
34	*G. edulis*												
35	*G. folifera*												
	TOTAL	93	99	189	87	75	80	102	115	109	69	67	91

TABLE - 13b

SEASONWISE ABUNDANCE (IN NUMBER) OF SEAWEEDS IN DIFFERENT SYSTEMS (STATIONS).

Sl. No.	SPECIES	STATION-3						STATION-4					
		INTERTIDAL			SUBTIDAL			INTERTIDAL			SUBTIDAL		
		Pre-Mon.	Mon.	Post-Mon.	Pre-Mon.	Mon.	Post-Mon.	Pre-Mon.	Mon.	Post-Mon.	Pre-Mon.	Mon.	Post-Mon
1	(OA)*Enteromorpha compressa*	27	24	25					10	25			
2	*Ulva spp.*		4	6					2	10			
3	*Chaetomorpha antennina*									5			
4	*Cladophora marina*												
5	*Caulerpa spp.*	7	1	4									
6	*Acetabularia calyculus*		20	20						7			
7	*Codium spp.*							8	5		6	4	5
8	*Halimeda spp.*	11	10	5	18	9	15	7	3	14	8	11	5
9	*Valoniopsis pachynema*			2				11					
10	*Ectocarpus siliculosus*								11				
11	*Dictyota dichotoma*		10										
12	*Hydroclathrus clathratus*					3	6					3	4
13	*Amphiroa spp.*				5	2	12				4	4	6
14	*Jania rubens*		3	3		3	15		4	25		4	9
15	*Grateloupia spp*				6	4					2	5	
16	*Hypnea spp.*		3	5		4	6						
17	*Galaxaura oblongata*	4		3									
18	*Ceramium avalona*								7	7			
19	*Laurencia papilosa*	8	1	4				6	2	2	5	3	3
20	(AL)*Padina tetrastomatica*		15	5		22	6		14	13		9	11
21	*P. gymnospora*	11	4	10	10	20	10	7	9	2	8	17	4
22	*Sargassum ilicifolium*	7	5	3	7	17	9	6	4	5	4	10	2
23	*S. myriosystem*	9	5	4	4	14	21	4	8	2	5	4	8
24	*S. duplicatum*					62	9			8			
25	*S. tennerium*					16							
26	*S. wightii*	5	7	9	5	9	4	3	5	8	10	5	16
27	*Turbinaria conoides*	5	12	2	5	16	8						
28	*T. ornata*	8	31	4	6	4	9						
29	*T. turbinata*			5		16	25		7	10		4	20
30	(AG)*Gelidium heteroplatus*		7					17	3	4		4	
31	*Gelidiella acerosa*								6	3		12	2
32	*Gracilaria corticata*							8	2	13	5	2	5
33	*G. crassa*				5	5	21				11	9	10
34	*G. edulis*									2			5
35	*G. folifera*												5
	T O T A L	102	162	119	71	226	176	77	102	165	68	110	120

TABLE - 13c

SEASONWISE ABUNDANCE (IN NUMBER) OF SEAWEEDS IN DIFFERENT SYSTEMS (STATIONS).

Sl. No.	SPECIES	STATION-5					
		INTERTIDAL			SUBTIDAL		
		Pre-Mon.	Mon.	Post-Mon.	Pre-Mon.	Mon.	Post-Mon.
1	(OA) *Enteromorpha compressa*						
2	*Ulva spp.*						
3	*Chaetomorpha antennina*						
4	*Cladophora marina*	8		1			4
5	*Caulerpa spp.*		7				
6	*Acetabularia calyculus*						
7	*Codium spp.*						
8	*Halimeda spp.*	14	8	6	15	7	20
9	*Valoniopsis pachynema*		7	6		4	9
10	*Ectocarpus siliculosus*	8	16		7		
11	*Dictyota dichotoma*		3	6		9	12
12	*Hydroclathrus clathratus*			7		4	4
13	*Amphiroa spp.*				7	5	5
14	*Jania rubens*		2	2		5	13
15	*Grateloupia spp.*						
16	*Hypnea spp.*		8	4		5	9
17	*Galaxaura oblongata*						
18	*Ceramium avalona*		3	3			4
19	*Laurencia papilosa*	6	7	6	5	8	5
20	(AL) *Padina tetrastomatica*		8	9		9	12
21	*P. gymnospora*	10	8	8	5	3	16
22	*Sargassum ilicifolium*	5	3	13	3	7	8
23	*S. myriosystem*	2	5		4	4	
24	*S. duplicatum*			8			
25	*S. tennerium*						
26	*S. wightii*	3	3	12	2	6	6
27	*Turbinaria conoides*	7	29	4	5	8	4
28	*T. ornata*	4	5	5	4	4	4
29	*T. turbinata*						
30	(AG) *Gelidium heteroplatus*						
31	*Gelidiella acerosa*		4	6		4	2
32	*Gracilaria corticata*	4	4	16	4	8	5
33	*G. crassa*			6	5	8	7
34	*G. edulis*			2			6
35	*G. folifera*			6			4
	T O T A L	71	130	136	66	108	159

recorded at each consecutive station in both tidal parts and the relative magnitude of these changes is significant, for premonsoon to postmonsoon. when considering the seasonal changes, the frequency of the genus Sargassum one of the most important species according to economical point of view, varies seasonally form tall plant in the last period of monsoon upto postmonsoon and to mostly short basal holdfasts and primary axis in premonsoon periods. There are relatively few species like Chaetomorpha antennina, Acetabularia calyculus, Dictyota dichotoma, Padina tetrastomatica, Sargassum tennerium and Gracilaria corticata which have restricted distribution together with comparatively high abundance.

On consolidated reef rock the vegetation generally is much higher and denser than the adjacent loose rubble and muddy area which may be occasionally overturned, preventing light reaching the turf on the under surface. It has been understood from stations, 1st, 2nd and 3rd that the poor vegetation is because they don't have more consolidated reef near the intertidal part (Plate Ia). Also the 4th and 5th stations have good vegetation because of the consolidated reef and rock as substratum for the seaweeds (Plate 1b).

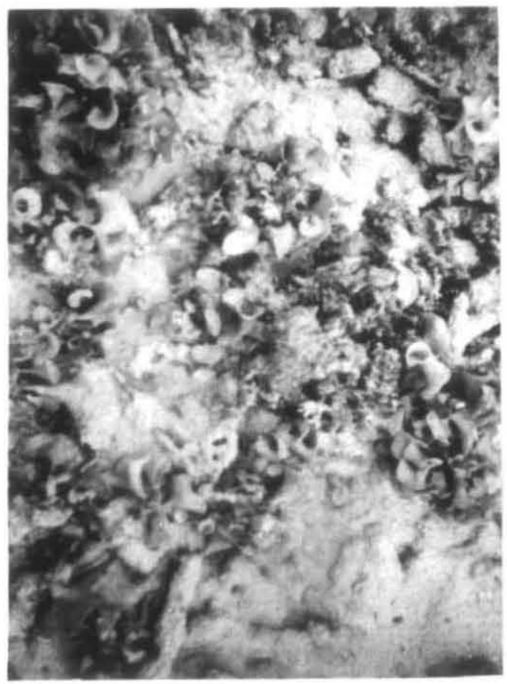
The seasonwise abundance total of all species shows (1) higher abundance of seaweeds in the interitial

PLATE – 1a

STATIONS WITH INTERTIDAL PARTS

STATION - 1
(College or Netaji park area)

STATION - 2
(Burmanala)



STATION - 3
(Cheriadappu)

PLATE - 1b

STATIONS WITH INTERTIDAL PARTS

STATION - 4
(Pongibalu)

STATION - 5
(Wandoor)

part than the subtidal part. (2) monsoon and postmonsoon have more abundance of seaweeds than premonsoon in most of the stations. Comparing all the stations, the subtidal part of station 1 has the low total abundance of 87, 75, and 80 in all three seasons.

iii) **Density**

The strength of the species in the total study area in the form of numerical strength and biomass is presented as density in the tables (14 and 15). The density (number) represents maximum values during premonsoon periods in most of the stations, but the density in biomass (fresh weight) represents higher density during postmonsoon periods than other two seasons in most of the stations. Both tidal parts of station III and intertidal part of station II are the exceptions where the numerical density is higher in postmonsoon periods. Since most of the species have their earlier growth during premonsoon, the species represents higher numerical density and lower density in biomass in most of the stations exhibit that during earlier growth the numerical density is higher for all species, since they have got lot of small number of species. When the species grow due to survival of the fittest, only limited species reach the matured stage. At the same time growth, which expresses the increment of weight and length of the

TABLE - 14 a

SEASONWISE DENSITY (IN NUMBER / m²) OF SEAWEEDS IN DIFFERENT SYSTEMS (STATIONS).

Sl. No.	SPECIES	STATION-1 INTERTIDAL Pre-Mon.	STATION-1 INTERTIDAL Mon.	STATION-1 INTERTIDAL Post-Mon.	STATION-1 SUBTIDAL Pre-Mon.	STATION-1 SUBTIDAL Mon.	STATION-1 SUBTIDAL Post-Mon.	STATION-2 INTERTIDAL Pre-Mon.	STATION-2 INTERTIDAL Mon.	STATION-2 INTERTIDAL Post-Mon.	STATION-2 SUBTIDAL Pre-Mon.	STATION-2 SUBTIDAL Mon.	STATION-2 SUBTIDAL Post-Mon
1	(OA) *Enteromorpha compressa*	12	13	24									
2	*Ulva spp.*		1	3									
3	*Chaetomorpha antennina*			5					2	5			
4	*Cladophora marina*												
5	*Caulerpa spp.*	2	2	2				3	5	2			
6	*Acetabularia calyculus*		9	15					10	1			
7	*Codium spp.*	1	3	1	1	1	2	2	1	2	2	3	2
8	*Halimeda spp.*	9	6	9	8	1	3	9	9	3	9	4	8
9	*Valoniopsis pachynema*					4				1			4
10	*Ectocarpus siliculosus*							4	5				
11	*Dictyota dichotoma*		2	3		2			1			1	2
12	*Hydroclathrus clathratus*												
13	*Amphiroa spp.*				2	3	3				1	3	4
14	*Jania rubens*					4	5						
15	*Grateloupia spp.*										2	1	2
16	*Hypnea spp.*								2	1			1
17	*Galaxaura oblongata*							2		1			
18	*Ceramium avalona*								1	2			
19	*Laurencia papilosa*												
20	(AL) *Padina tetrastomatica*												
21	*P. gymnospora*	3	2	3	4	3	2	3	2	2	5	2	1
22	*Sargassum ilicifolium*	1	2	2	3	3	2	2	1	3	2	3	1
23	*S. myriosystem*												
24	*S. duplicatum*											2	4
25	*S. tennerium*		6			3	3					2	
26	*S. wightii*	1	4	4	1	1	5	1	4	1	1	1	5
27	*Turbinaria conoides*	1	6	2	1	2	2	2	15	2	1	2	3
28	*T. ornata*	2	3	3	2	1	4	2	5	1	1	3	1
29	*T. turbinata*				2			4	4	3			
30	(AG) *Gelidium heteroplatus*			4	3	2	1		2	2	3	3	3
31	*Gelidiella acerosa*		1	1			2						
32	*Gracilaria corticata*					4							
33	*G. crassa*												
34	*G. edulis*												
35	*G. folifera*												
	T O T A L	32	60	81	27	34	34	34	79	32	27	30	41

TABLE - 14b

SEASONWISE DENSITY (IN NUMBER / m^2) OF SEAWEEDS IN DIFFERENT SYSTEMS (STATIONS).

Sl. No.	SPECIES	STATION-3						STATION-4					
		INTERTIDAL			SUBTIDAL			INTERTIDAL			SUBTIDAL		
		Pre-Mon.	Mon.	Post-Mon	Pre-Mon.	Mon.	Post-Mon.	Pre-Mon.	Mon.	Post-Mon.	Pre-Mon.	Mon.	Post-Mon
1	(OA)*Enteromorpha compressa*	14	8	20				11	4	15			
2	*Ulva spp.*	2	3						1	4			
3	*Chaetomorpha antennina*								2	3			
4	*Cladophora marina*							1					
5	*Caulerpa spp.*	4	1	1									
6	*Acetabularia calyculus*		12	8									
7	*Codium spp.*							2	3	2	2	2	2
8	*Halimeda spp.*	8	8	3	9	8	9	4	2	10	6	6	4
9	*Valoniopsis pachynema*			1									
10	*Ectocarpus siliculosus*							4	6				
11	*Dictyota dichotoma*		3										
12	*Hydroclathrus clathratu*					1	2					2	3
13	*Amphiroa spp.*				2	1	4				2	2	5
14	*Jania rubens*		1	3		1	6		2	5		1	6
15	*Grateloupia spp.*				1	1					1	2	
16	*Hypnea spp.*		2	3		2	2						
17	*Galaxaura oblongata*	1		2									
18	*Ceramium avalona*								3	2			
19	*Laurencia papilosa*	2	1	2				2	1	1	2	1	2
20	(AL)*Padina tetrastomatica*		9	4		9	5		4	8		9	10
21	*P. gymnospora*	6	1	4	3	14	3	3	4	1	3	10	1
22	*Sargassum ilicifolium*	1	1	2	1	9	2	2	1	1	2	7	2
23	*S. myriosystem*	2	2	3	1	6	8	2	1	1	1	1	3
24	*S. duplicatum*					12	2			4			8
25	*S. tennerium*					5							
26	*S. wightii*	2	4	9	1	4	3	1	2	4	2	2	4
27	*Turbinaria conoides*	1	7	1	1	6	5						
28	*T. ornata*	2	10	2	1	3	3						
29	*T. turbinata*			2		5	5		3	4		3	4
30	(AG)*Gelidium heteroplatus*		4					3	1	2		1	
31	*Gelidiella acerosa*								3	1		1	1
32	*Gracilaria corticata*							2	1	4	2	1	4
33	*G. crassa*				1	3	2				2	2	4
34	*G. edulis*									1			1
35	*G. folifera*									1			2
	T O T A L	45	77	70	21	90	61	37	44	74	25	53	66

TABLE - 14c

SEASONWISE DENSITY (IN NUMBER / m^2) OF SEAWEEDS IN DIFFERENT SYSTEMS (STATIONS).

Sl. No.	SPECIES	STATION-5					
		INTERTIDAL			SUBTIDAL		
		Pre-Mon.	Mon.	Post-Mon.	Pre-Mon.	Mon.	Post-Mon.
1	(OA)*Enteromorpha compressa*						
2	*Ulva spp.*						
3	*Chaetomorpha antennina*						
4	*Cladophora marina*	2		1			2
5	*Caulerpa spp.*		2				
6	*Acetabularia calyculus*						
7	*Codium spp.*						
8	*Halimeda spp.*	7	5	4	6	4	20
9	*Valoniopsis pachynema*		4	4		1	8
10	*Ectocarpus siliculosus*	4	3		3		
11	*Dictyota dichotoma*		3	4		4	5
12	*Hydroclathrus clathratus*			4		1	1
13	*Amphiroa spp.*				3	2	3
14	*Jania rubens*		1	1		3	6
15	*Grateloupia spp.*						
16	*Hypnea spp.*		5	1		1	3
17	*Galaxaura oblongata*						
18	*Ceramium avalona*		1	2			2
19	*Laurencia papilosa*	2	4	3	2	8	2
20	(AL)*Padina tetrastomatica*		1	3		9	9
21	*P. gymnospora*	3	5	2	2	1	5
22	*Sargassum ilicifolium*	2	2	9	1	2	2
23	*S. myriosystem*	1	4		1	1	
24	*S. duplicatum*			3			
25	*S. tennerium*						
26	*S. wightii*	1	1	8	1	1	4
27	*Turbinaria conoides*	2	9	3	1	1	2
28	*T. ornata*	2	2	2	2	3	1
29	*T. turbinata*						
30	(AG)*Gelidium heteroplatus*						
31	*Gelidiella acerosa*		2	2		1	2
32	*Gracilaria corticata*	1	2	2	2	1	3
33	*G. crassa*			4	1	3	2
34	*G. edulis*			1			2
35	*G. folifera*			2			1
	T O T A L	27	56	65	25	47	85

TABLE - 15a

SEASONWISE DENSITY (IN BIOMASS/m²) OF SEAWEEDS IN DIFFERENT SYSTEMS (STATIONS).

Sl. No.	SPECIES	STATION-1						STATION-2					
		INTERTIDAL			SUBTIDAL			INTERTIDAL			SUBTIDAL		
		Pre-Mon.	Mon.	Post-Mon.	Pre-Mon.	Mon.	Post-Mon.	Pre-Mon.	Mon.	Post-Mon.	Pre-Mon.	Mon.	Post-Mon
1	(OA)*Enteromorpha compressa*	10.90	4.10	14.80									
2	*Ulva spp.*		0.90	3.90									
3	*Chaetomorpha antennina*		2.10	2.70									
4	*Cladophora marina*	1.40						1.60		1.20			2.10
5	*Caulerpa spp.*								2.10				
6	*Acetabularia calyculus*												
7	*Codium spp.*	1.50	3.30	2.00	1.90	1.70	1.80	6.80	4.80	3.80	5.90	4.00	19.80
8	*Halimeda spp.*	3.90	1.80	10.10	5.60	6.40	3.90		4.40	4.30		1.20	8.40
9	*Valoniopsis pachynema*							3.90	3.10		2.90		
10	*Ectocarpus siliculosus*	4.30	5.70						3.10	3.60		4.30	4.80
11	*Dictyota dichotoma*									4.00		1.20	1.20
12	*Hydroclathrus clathratus*					1.80	2.50				2.60	2.30	3.10
13	*Amphiroa spp.*				1.60	2.10	4.80		1.20	1.30		2.50	6.40
14	*Jania rubens*		1.50	4.90		1.70	5.60						
15	*Grateloupia spp.*				0.90	1.50			4.90	0.80		1.00	2.60
16	*Hypnea spp.*												
17	*Galaxaura oblongata*								1.20	1.80			2.10
18	*Ceramium avalona*		2.70	2.10				2.20	4.10	2.90	2.30	8.10	2.10
19	*Laurencia papilosa*	1.70	0.70	0.80	2.10	0.30	1.50		0.80	2.80		9.40	9.40
20	(AL)*Padina tetrastomatica*		4.10	7.90		9.10	10.10	3.10	4.90	1.50	1.90	1.00	4.90
21	*P. gymnospora*	2.60	3.60	1.20	3.30	9.90	0.80	2.10	2.20	8.90	1.00	2.10	2.40
22	*Sargassum ilicifolium*	1.70	1.20	0.50	2.10	7.30	1.50	0.40	3.80		0.80	0.80	
23	*S. myriosystem*	1.90	0.80	0.50	1.40	1.20	2.50			3.10			
24	*S. duplicatum*			4.10			8.40						
25	*S. tennerium*							1.30	1.20	8.40	1.20	1.20	4.10
26	*S. wightii*	1.10	1.50	4.20	1.90	2.40	4.80	2.00	8.80	3.00	1.40	0.80	2.20
27	*Turbinaria conoides*							1.70	1.50	1.80	1.90	3.10	0.80
28	*T. ornata*												
29	*T. turbinata*		2.90	4.00		3.10	3.90						
30	(AG)*Gelidium heteroplatus*	3.30	1.10	1.50		0.80							
31	*Gelidiella acerosa*		2.90	0.80		1.20	1.20		2.10	1.80		1.20	2.10
32	*Gracilaria corticata*	1.60	0.90	3.90	2.10	0.80	4.10	1.30	1.70	1.60	2.10	0.80	2.90
33	*G. crassa*				2.10	1.80	4.10			4.20	1.40	2.50	2.00
34	*G. edulis*			1.40			0.90			1.20			2.30
35	*G. folifera*			1.10			2.10			1.80			1.20
	T O T A L	35.90	41.80	72.40	25.50	53.10	62.10	26.40	55.90	63.80	25.40	47.50	86.90

TABLE - 15b

SEASONWISE DENSITY (IN BIOMASS/m²) OF SEAWEEDS IN DIFFERENT SYSTEMS (STATIONS).

Sl. No.	SPECIES	STATION-3						STATION-4					
		INTERTIDAL			SUBTIDAL			INTERTIDAL			SUBTIDAL		
		Pre-Mon.	Mon.	Post-Mon.	Pre-Mon.	Mon.	Post-Mon.	Pre-Mon.	Mon.	Post-Mon.	Pre-Mon.	Mon.	Post-Mon
1	(OA)*Enteromorpha compressa*	6.69	18.34	18.34									
2	*Ulva spp.*		4.86	5.71									
3	*Chaetomorpha antennina*			2.87					2.87	2.94			
4	*Cladophora marina*		1.64										
5	*Caulerpa spp.*	1.93		1.64				2.14	1.91	1.44			
6	*Acetabularia calyculus*		4.18	6.70					12.01	7.15			
7	*Codium spp.*	1.67	3.48	3.04	1.60	1.89	3.34	1.71	1.81	2.83	1.83	3.15	2.63
8	*Halimeda spp.*	45.74	61.85	27.50	42.33	1.23	14.84	41.13	59.85	4.93	46.18	42.92	24.14
9	*Valoniopsis pachynema*					5.73	9.93			1.53			7.94
10	*Ectocarpus siliculosus*							0.63	1.27				
11	*Dictyota dichotoma*		8.47	5.87		4.13	1.43					1.81	4.14
12	*Hydroclathrus clathratus*												
13	*Amphiroa spp.*				3.66	9.82	10.93				2.88	8.13	12.01
14	*Jania rubens*					6.27	6.43						
15	*Grateloupia spp.*										1.34	2.41	1.25
16	*Hypnea spp.*								3.14	1.54		4.93	0.95
17	*Galaxaura oblongata*							1.26		1.84			
18	*Ceramium avalona*								1.02	1.02			
19	*Laurencia papilosa*												
20	(AL)*Padina tetrastomatica*												
21	*P. gymnospora*	16.14	3.94	22.51	14.37	9.14	6.52	11.14	1.44	1.54	15.16	3.48	1.28
22	*Sargassum ilicifolium*	5.42	3.41	16.42	4.93	3.65	4.84	3.94	1.82	1.14	6.32	2.94	0.84
23	*S. myriosystem*												
24	*S. duplicatum*											7.13	7.79
25	*S. tennerium*		26.85			12.13	17.30					8.10	
26	*S. wightii*	4.82	42.56	10.78	3.31	4.84	9.83	4.22	7.85	1.50	3.38	2.90	9.67
27	*Turbinaria conoides*	4.93	43.41	26.35	4.21	14.93	3.23	4.32	34.93	1.20	2.64	3.34	4.33
28	*T. ornata*	5.21	26.85	18.02	4.93	0.81	3.21	4.93	22.43	1.02	2.13	12.03	1.53
29	*T. turbinata*				6.10				11.41	7.00			
30	(AG)*Gelidium heteroplatus*			14.33	3.61	3.51	0.81	4.13	8.13	1.53	3.14	4.93	0.34
31	*Gelidiella acerosa*		1.41	6.76			0.96						
32	*Gracilaria corticata*					14.52							
33	*G. crassa*												
34	*G. edulis*												
35	*G. folifera*												
	TOTAL	92.55	251.25	186.84	89.05	92.60	93.60	79.55	171.89	40.15	85.00	108.20	78.84

TABLE - 15c

SEASONWISE DENSITY (IN BIOMASS/m^2) OF SEAWEEDS IN DIFFERENT SYSTEMS (STATIONS).

Sl. No.	SPECIES	STATION-5					
		INTERTIDAL			SUBTIDAL		
		Pre-Mon.	Mon.	Post-Mon	Pre-Mon.	Mon.	Post-Mon.
1	(OA)*Enteromorpha compressa*	7.97	11.10	14.83			
2	*Ulva spp.*		6.10	4.80			
3	*Chaetomorpha antennina*						
4	*Cladophora marina*						
5	*Caulerpa spp.*	2.63	1.20	1.43			
6	*Acetabularia calyculus*		18.53	4.13			
7	*Codium spp.*						
8	*Halimeda spp.*	36.32	52.31	13.03	43.13	49.83	18.44
9	*Valoniopsis pachynema*			1.50			
10	*Ectocarpus siliculosus*						
11	*Dictyota dichotoma*		3.83				
12	*Hydroclathrus clathratus*					1.09	3.20
13	*Amphiroa spp.*				3.13	2.71	12.29
14	*Jania rubens*		1.41	4.13		0.94	7.87
15	*Grateloupia spp.*				1.12	2.41	
16	*Hypnea spp.*		3.61	2.13		3.07	2.84
17	*Galaxaura oblongata*	1.46		1.42			
18	*Ceramium avalona*						
19	*Laurencia papilosa*	3.53	1.05	5.88			
20	(AL)*Padina tetrastomatica*		34.03	5.04		34.08	24.83
21	*P. gymnospora*	14.31	1.93	4.83	11.04	27.35	8.41
22	*Sargassum ilicifolium*	4.93	2.73	2.02	5.94	52.67	3.41
23	*S. myriosystem*	7.25	3.53	16.16	6.94	59.89	11.40
24	*S. duplicatum*					22.45	8.90
25	*S. tennerium*					14.93	
26	*S. wightii*	1.14	26.10	11.51	4.13	39.04	10.13
27	*Turbinaria conoides*	1.54	29.30	0.84	3.11	43.41	24.10
28	*T. ornata*	2.63	30.64	1.25	2.06	3.94	18.90
29	*T. turbinata*			0.35		26.12	10.00
30	(AG)*Gelidium heteroplatus*		19.82				
31	*Gelidiella acerosa*						
32	*Gracilaria corticata*						
33	*G. crassa*				1.32	4.71	2.89
34	*G. edulis*						
35	*G. folifera*						
	T O T A L	83.71	247.22	95.29	81.92	383.93	167.61

organism, automatically shows increased in density in biomass.

iv) Cover (Tables a, b, c)

Cover is an expression of the area covered or occupied by different species, here it is presented in percentage (%) cover. Cover is of great ecological significance because although the frequency and density (number) have more values for small plants than bigger ones, yet the dominating influence of bigger plants may be greater in the community because of their more extensive canopy coverage, especially species like Sargassum and Turbinaria have the domination. In general the monsoon presents the more cover in most of the cases and rest is by postmonsoon. Here also Halimeda spp. have the higher level of percentage cover, followed by the Sargassum spp. and Turbinaria spp. The maximum coverage of 42.2% has been recorded in the intertidal area of station V, during monsoon followed by 39.40% (S3ST) 32.5 in both S5IT & ST. But comparing to station I and II the station III, IV, and V show very good coverage. Most of the lowest percentage cover are exhibited in the premonsoon season. The postmonsoon period shows the percentage cover nearly to monsoon because of their matured stages in the growth of most of the species during this season. In station IV and V most of the species have more coverage than the other stations.

TABLE - 16a

SEASONWISE COVERAGE (IN %) OF SEAWEEDS IN DIFFERENT SYSTEMS (STATIONS).

Sl. No.	SPECIES	STATION-1						STATION-2					
		INTERTIDAL			SUBTIDAL			INTERTIDAL			SUBTIDAL		
		Pre-Mon.	Mon.	Post-Mon	Pre-Mon.	Mon.	Post-Mon.	Pre-Mon.	Mon.	Post-Mon.	Pre-Mon.	Mon.	Post-Mon
1	(OA)*Enteromorpha compressa*	1.5	1.9	2.5									
2	*Ulva spp.*		1.3	1.4									
3	*Chaetomorpha antennina*			1.0					1.2	0.9			
4	*Cladophora marina*												
5	*Caulerpa spp.*	0.9	1.4	0.9				1.1	1.0	0.8			
6	*Acetabularia calyculus*		1.0	1.6					0.9	1.4			
7	*Codium spp.*	0.8	1.3	1.5	0.9	0.3	1.3	1.0	1.0	1.2	1.0	1.4	1.1
8	*Halimeda spp.*	4.8	8.3	1.3	4.3	0.3	1.4	3.6	7.8	0.7	4.7	3.0	1.5
9	*Valoniopsis pachynema*		0.6			0.8	5.7			0.3			1.5
10	*Ectocarpus siliculosus*							0.6	0.9				
11	*Dictyota dichotoma*		2.0	1.4		1.8	0.5		0.8			0.3	1.0
12	*Hydroclathrus clathratus*												
13	*Amphiroa spp.*				1.7	2.1	2.7				1.5	1.4	2.2
14	*Jania rubens*					1.2	1.1						
15	*Grateloupia spp.*										1.2	0.9	0.4
16	*Hypnea spp.*								1.0	0.4		1.1	0.2
17	*Galaxaura oblongata*							0.4		0.4			
18	*Ceramium avalona*								0.3	0.8			
19	*Laurencia papilosa*												
20	(AL)*Padina tetrastomatica*												
21	*P. gymnospora*	1.8	0.5	3.0	1.9	2.0	0.9	1.3	0.6	1.1	2.1	1.8	0.3
22	*Sargassum ilicifolium*	0.9	0.7	2.1	0.9	1.2	0.8	0.8	0.3	0.6	1.0	0.6	0.1
23	*S. myriosystem*												
24	*S. duplicatum*											1.7	1.1
25	*S. tennerium*		2.4			2.0	1.1					0.8	
26	*S. wightii*	0.8	3.0	1.9	0.8	0.6	2.0	1.1	1.4	0.3	0.6	0.7	1.3
27	*Turbinaria conoides*	1.0	2.2	2.9	1.1	1.4	1.5	1.3	4.4	0.4	0.5	1.2	1.0
28	*T. ornata*	0.8	2.7	1.7	0.9	0.1	0.7	1.1	3.2	0.1	0.4	1.8	0.4
29	*T. turbinata*				1.1				1.9	1.3			
30	(AG)*Gelidium heteroplatus*			0.6	0.9	1.1	0.2	1.1	1.1	0.4	0.9	1.1	0.3
31	*Gelidiella acerosa*		0.4	1.3			0.5						
32	*Gracilaria corticata*					3.4							
33	*G. crassa*												
34	*G. edulis*												
35	*G. folifera*												
	TOTAL	13.30	29.70	25.70	14.50	18.30	23.10	13.40	27.80	11.10	13.90	17.80	12.40

TABLE - 16b

SEASONWISE COVERAGE (IN %) OF SEAWEEDS IN DIFFERENT SYSTEMS (STATIONS).

Sl. No.	SPECIES	STATION-3						STATION-4					
		INTERTIDAL			SUBTIDAL			INTERTIDAL			SUBTIDAL		
		Pre-Mon.	Mon.	Post-Mon	Pre-Mon.	Mon.	Post-Mon.	Pre-Mon.	Mon.	Post-Mon.	Pre-Mon.	Mon.	Post-Mon
1	(OA)*Enteromorpha compressa*		1.9	2.1				1.4	1.2	2.5			
2	*Ulva spp.*		1.0	1.2					0.4	1.0			
3	*Chaetomorpha antennina*								0.6	0.9			
4	*Cladophora marina*							0.6					
5	*Caulerpa spp.*	1.4	0.5	0.6									
6	*Acetabularia calyculus*		1.5	0.6									
7	*Codium spp.*							0.7	1.4	0.6	0.9	0.4	1.0
8	*Halimeda spp.*	4.0	5.4	0.7	4.1	6.4	1.2	5.0	1.2	4.1	1.1	2.1	1.4
9	*Valoniopsis pachynema*			0.7									
10	*Ectocarpus siliculosus*							0.4	0.8				
11	*Dictyota dichotoma*		1.1										
12	*Hydroclathrus clathratus*					1.9	2.1					1.5	1.5
13	*Amphiroa spp.*				1.4	0.8	2.6				1.1	1.1	1.2
14	*Jania rubens*		0.9	0.8		0.3	1.1		1.0	1.0		1.4	1.0
15	*Grateloupia spp.*				0.9	1.1					0.8	0.9	
16	*Hypnea spp.*		1.0	0.5		1.2	0.9						
17	*Galaxaura oblongata*	0.4		0.4									
18	*Ceramium avalona*								0.4	0.8			
19	*Laurencia papilosa*	0.7	0.6	1.2				0.7	0.7	0.3	0.7	0.3	0.9
20	(AL)*Padina tetrastomatica*		3.3	2.5		3.3	5.1		1.2	5.4		3.5	6.1
21	*P. gymnospora*	2.3	1.0	0.8	1.6	3.9	2.0	1.2	1.8	0.3	1.4	3.6	1.0
22	*Sargassum ilicifolium*	0.9	0.8	0.5	0.9	3.6	0.5	1.0	0.7	0.3	1.0	4.2	0.7
23	*S. myriosystem*	0.6	1.4	0.7	0.7	2.1	2.2	0.6	0.4	0.3	0.8	1.1	0.5
24	*S. duplicatum*					4.0	1.5			1.3			4.2
25	*S. tennerium*					2.1							
26	*S. wightii*	0.9	1.4	1.4	0.7	3.0	2.0	0.6	0.3	1.8	0.7	3.2	2.9
27	*Turbinaria conoides*	1.1	1.7	0.2	0.9	1.4	1.4						
28	*T. ornata*	1.2	4.9	0.4	0.9	0.9	1.6						
29	*T. turbinata*			0.4		1.9	2.1		1.4	1.4		1.1	3.1
30	(AG)*Gelidium heteroplatus*		3.1					0.7	0.5	0.8		0.2	
31	*Gelidiella acerosa*								1.7	0.2		0.4	0.5
32	*Gracilaria corticata*							0.6	0.7	3.1	0.5	0.4	1.1
33	*G. crassa*				0.3	1.5	0.9				0.3	0.6	0.9
34	*G. edulis*									1.2			0.3
35	*G. folifera*									0.4			0.6
	T O T A L	13.50	31.50	15.70	12.40	39.40	27.20	13.50	16.40	27.70	9.30	26.00	28.90

TABLE - 16c
SEASONWISE COVERAGE (IN %) OF SEAWEEDS IN DIFFERENT SYSTEMS (STATIONS).

Sl. No.	SPECIES	STATION-5					
		INTERTIDAL			SUBTIDAL		
		Pre-Mon.	Mon.	Post-Mon	Pre-Mon.	Mon.	Post-Mon.
1	(OA)*Enteromorpha compressa*						
2	*Ulva spp.*						
3	*Chaetomorpha antennina*						
4	*Cladophora marina*	1.0		1.1			0.9
5	*Caulerpa spp.*		0.7				
6	*Acetabularia calyculus*						
7	*Codium spp.*						
8	*Halimeda spp.*	1.3	2.6	2.1	2.6	3.4	5.6
9	*Valoniopsis pachynema*		8.1	1.0		0.6	1.4
10	*Ectocarpus siliculosus*	0.5	0.3		0.4		
11	*Dictyota dichotoma*		1.3	2.1		1.8	1.5
12	*Hydroclathrus clathratus*			1.5		0.9	0.6
13	*Amphiroa spp.*				1.1	1.9	0.7
14	*Jania rubens*		0.9	0.4		1.9	0.4
15	*Grateloupia spp.*						
16	*Hypnea spp.*		8.5	0.9		1.8	0.8
17	*Galaxaura oblongata*						
18	*Ceramium avalona*		4.3	0.4			0.9
19	*Laurencia papilosa*	0.9	1.5	0.5	0.7	4.0	0.3
20	(AL)*Padina tetrastomatica*		0.9	1.0		7.5	2.9
21	*P. gymnospora*	1.1	2.9	0.8	0.9	0.8	1.5
22	*Sargassum ilicifolium*	1.0	1.2	2.5	0.6	0.9	4.1
23	*S. myriosystem*	0.3	3.0		0.4	1.6	
24	*S. duplicatum*			5.9			
25	*S. tennerium*						
26	*S. wightii*	0.6	1.8	4.9	0.4	1.9	3.8
27	*Turbinaria conoides*	0.4	1.8	2.9	0.3	1.3	1.4
28	*T. ornata*	0.8	1.2	1.9	0.5	0.9	0.4
29	*T. turbinata*						
30	(AG)*Gelidium heteroplatus*						
31	*Gelidiella acerosa*		0.7	0.5		0.4	0.6
32	*Gracilaria corticata*	0.4	0.5	0.4	0.4	0.3	0.8
33	*G. crassa*			0.6	0.4	0.6	0.4
34	*G. edulis*			0.6			0.9
35	*G. folifera*			0.5			0.8
	T O T A L	8.3	42.2	32.5	8.7	32.5	30.7

v) Dominance (Tables 17a, b, c)

The results of dominant species which have strongest control over energy flow and the environment in a given habitat are presented in the table. According to the index of dominance, the communities where more than one species contribute very highly the dominace is quite high showing values more than 0.5 and when all or most of the constituent species share the number of biomass almost equally and the dominace values are low. But if one individual dominates the rest of the species then it gives the highest index of dominance (0.829). In South Andaman because of more than one species domination in all stations during all three seasons, the value shows below 0.5. Among the individual species the Sargassum spp., Turbinaria spp. and Halimeda spp. show the dominant index in all stations. The average of dominant index values in both intertidal and subtidal parts of all five stations have been given in the tabular form. The maximum dominant index values are derived mostly from the Intertidal part. The dominant index is low during premonsoon and gradually increases upto postmonsoon period. Since the premonsoon allows the earlier growth for most of the species, the dominant flow is shared by many number of species during the premonsoon period. But when they attain mature state the number of dominant species reduces and only climax species and few seral species have

TABLE - 17a

SEASONWISE SEAWEEDS INDEX OF DOMINANCE IN DIFFERENT SYSTEMS (STATIONS).

Sl. No.	SPECIES	STATION-1						STATION-2					
		INTERTIDAL			SUBTIDAL			INTERTIDAL			SUBTIDAL		
		Pre-Mon.	Mon.	Post-Mon	Pre-Mon.	Mon.	Post-Mon.	Pre-Mon.	Mon.	Post-Mon.	Pre-Mon.	Mon.	Post-Mon
1	(OA) *Enteromorpha compressa*	0.131	0.046	0.090									
2	*Ulva spp.*		0.001	0.001									
3	*Chaetomorpha antennina*								0.001	0.014			
4	*Cladophora marina*			0.004									
5	*Caulerpa spp.*	0.003	0.001	0.001				0.009	0.004	0.003			
6	*Acetabularia calyculus*		0.020	0.034					0.019	0.079			
7	*Codium spp.*	0.001	0.002	0.002	0.001	0.001	0.002	0.002	0.003	0.002	0.006	0.010	0.003
8	*Halimeda spp.*	0.072	0.010	0.011	0.092	0.002	0.005	0.079	0.019	0.004	0.120	0.017	0.038
9	*Valoniopsis pachynema*					0.012	0.039			0.001			0.011
10	*Ectocarpus siliculosus*							0.015	0.005				
11	*Dictyota dichotoma*		0.002	0.001		0.004	0.001		0.003			0.002	0.002
12	*Hydroclathrus clathratus*												
13	*Amphiroa spp.*				0.008	0.008	0.006				0.001	0.010	0.010
14	*Jania rubens*					0.015	0.017						
15	*Grateloupia spp.*										0.006	0.001	0.002
16	*Hypnea spp.*								0.001	0.001		0.005	0.001
17	*Galaxaura oblongata*							0.003		0.001			
18	*Ceramium avalona*								0.001	0.002			
19	*Laurencia papilosa*												
20	(AL) *Padina tetrastomatica*												
21	*P. gymnospora*	0.012	0.001	0.002	0.020	0.009	0.001	0.009	0.001	0.002	0.035	0.004	0.005
22	*Sargassum ilicifolium*	0.002	0.002	0.001	0.005	0.008	0.002	0.002	0.001	0.005	0.004	0.010	0.001
23	*S. myriosystem*												
24	*S. duplicatum*											0.004	0.010
25	*S. tennerium*		0.010			0.009	0.004					0.005	
26	*S. wightii*	0.001	0.004	0.002	0.001	0.001	0.013	0.002	0.004	0.003	0.001	0.001	0.013
27	*Turbinaria conoides*	0.001	0.011	0.001	0.003	0.003	0.003	0.002	0.050	0.003	0.001	0.004	0.005
28	*T. ornata*	0.004	0.003	0.001	0.007	0.002	0.001	0.004	0.005	0.004	0.001	0.009	0.001
29	*T. turbinata*				0.006					0.006			
30	(AG) *Gelidium heteroplatus*			0.002	0.013	0.002	0.001	0.012	0.004	0.002	0.012	0.003	0.005
31	*Gelidiella acerosa*		0.001	0.002			0.002		0.001				
32	*Gracilaria corticata*					0.015							
33	*G. crassa*												
34	*G. edulis*												
35	*G. folifera*												
	T O T A L	0.227	0.114	0.155	0.156	0.091	0.097	0.139	0.122	0.132	0.187	0.085	0.107

TABLE - 17b

SEASONWISE SEAWEEDS INDEX OF DOMINANCE IN DIFFERENT SYSTEMS (STATIONS).

Sl. No.	SPECIES	STATION-3						STATION-4					
		INTERTIDAL			SUBTIDAL			INTERTIDAL			SUBTIDAL		
		Pre-Mon.	Mon.	Post-Mon	Pre-Mon.	Mon.	Post-Mon.	Pre-Mon.	Mon.	Post-Mon.	Pre-Mon.	Mon.	Post-Mon
1	(OA)*Enteromorpha compressa*	0.106	0.011	0.080				0.092	0.010	0.042			
2	*Ulva spp.*		0.001	0.002					0.001	0.003			
3	*Chaetomorpha antennina*								0.003	0.001			
4	*Cladophora marina*							0.002					
5	*Caulerpa spp.*	0.008	0.001	0.003									
6	*Acetabularia calyculus*		0.025	0.013									
7	*Codium spp.*							0.002	0.006	0.001	0.006	0.001	0.001
8	*Halimeda spp.*	0.033	0.012	0.002	0.175	0.008	0.024	0.012	0.002	0.020	0.050	0.020	0.004
9	*Valoniopsis pachynema*												
10	*Ectocarpus siliculosus*							0.014	0.019				
11	*Dictyota dichotoma*		0.002										
12	*Hydroclathrus clathratus*					0.001	0.009					0.002	0.002
13	*Amphiroa spp.*				0.005	0.001	0.004				0.004	0.002	0.006
14	*Jania rubens*		0.003	0.002		0.002	0.016		0.001	0.005		0.001	0.008
15	*Grateloupia spp.*				0.003	0.001					0.001	0.001	
16	*Hypnea spp.*		0.001	0.002		0.001	0.001						
17	*Galaxaura oblongata*	0.001		0.001									
18	*Ceramium avalona*								0.004	0.001			
19	*Laurencia papilosa*	0.003	0.001	0.001				0.002	0.001	0.001	0.007		0.001
20	(AL)*Padina tetrastomatica*		0.013	0.003		0.010	0.007		0.010	0.012		0.030	0.025
21	*P. gymnospora*	0.019	0.001	0.003	0.020	0.024	0.002	0.005	0.007	0.001	0.017	0.035	0.001
22	*Sargassum ilicifolium*	0.001	0.001	0.001	0.004	0.009	0.001	0.002	0.001		0.007	0.019	0.001
23	*S. myriosystem*			0.001	0.003	0.004	0.019	0.003	0.001		0.001	0.001	0.001
24	*S. duplicatum*					0.019	0.001			0.003			0.017
25	*S. tennerium*					0.003							
26	*S. wightii*	0.001	0.003	0.015	0.004	0.002	0.002	0.001	0.001	0.003	0.006	0.002	0.006
27	*Turbinaria conoides*	0.001	0.010	0.001	0.002	0.005	0.007						
28	*T. ornata*	0.001	0.015	0.001	0.003	0.001	0.002						
29	*T. turbinata*			0.001		0.003	0.007		0.005	0.003		0.003	0.004
30	(AG)*Gelidium heteroplatus*		0.003					0.009	0.001	0.001		0.001	
31	*Gelidiella acerosa*								0.005	0.001		0.001	0.001
32	*Gracilaria corticata*	0.102						0.002	0.001	0.003	0.007	0.001	0.004
33	*G. crassa*				0.002	0.001	0.001				0.007	0.001	0.004
34	*G. edulis*									0.001			0.001
35	*G. folifera*									0.001			0.001
	T O T A L	0.276	0.103	0.132	0.221	0.095	0.103	0.146	0.079	0.190	0.113	0.121	0.088

TABLE - 17c

SEASONWISE SEAWEEDS INDEX OF DOMINANCE IN DIFFERENT SYSTEMS (STATIONS).

Sl. No.	SPECIES	STATION-5					
		INTERTIDAL			SUBTIDAL		
		Pre-Mon.	Mon.	Post-Mon	Pre-Mon.	Mon.	Post-Mon.
1	(OA.) *Enteromorpha compressa*						
2	*Ulva spp.*						
3	*Chaetomorpha antennina*						
4	*Cladophora marina*	0.004		0.001			0.001
5	*Caulerpa spp.*		0.001				
6	*Acetabularia calyculus*						
7	*Codium spp.*						
8	*Halimeda spp.*	0.066	0.007	0.004	0.060	0.007	0.052
9	*Valoniopsis pachynema*		0.006	0.005		0.001	0.009
10	*Ectocarpus siliculosus*	0.022	0.003		0.013		
11	*Dictyota dichotoma*		0.003	0.003		0.008	0.003
12	*Hydroclathrus clathratus*			0.004		0.001	0.001
13	*Amphiroa spp.*				0.011	0.004	0.001
14	*Jania rubens*		0.001	0.001		0.003	0.005
15	*Grateloupia spp.*						
16	*Hypnea spp.*		0.007	0.001		0.001	0.001
17	*Galaxaura oblongata*						
18	*Ceramium avalona*		0.001	0.001			0.058
19	*Laurencia papilosa*	0.007	0.005	0.002	0.008	0.028	0.058
20	(AL.) *Padina tetrastomatica*		0.001	0.002		0.038	0.012
21	*P. gymnospora*	0.014	0.008	0.001	0.006	0.001	0.003
22	*Sargassum ilicifolium*	0.006	0.002	0.019	0.002	0.002	0.001
23	*S. myriosystem*	0.001	0.005		0.001	0.001	
24	*S. duplicatum*			0.002			
25	*S. tennerium*	0.002	0.001	0.017	0.002	0.001	0.002
26	*S. wightii*	0.006	0.025	0.002	0.003	0.001	0.001
27	*Turbinaria conoides*	0.004	0.001	0.001	0.006	0.004	0.001
28	*T. ornata*						
29	*T. turbinata*						
30	(AG.) *Gelidium heteroplatus*						
31	*Gelidiella acerosa*		0.001	0.001		0.001	0.001
32	*Gracilaria corticata*	0.002	0.001	0.001	0.007	0.001	0.001
33	*G. crassa*			0.004	0.003	0.003	0.001
34	*G. edulis*			0.001			0.001
35	*G. folifera*			0.001			0.001
	T O T A L	0.134	0.079	0.074	0.122	0.106	0.214

the dominant flow which may be the probable reason for getting high dominant index in postmonsoon season. Overall, the indices of dominant responses below 0.5 by allowing more than one species in the dominant flow of the community.

vi. Patterns of distribution

The structure of the natural community depends on the way in which plants are distributed or dispersed in it. The pattern of distribution depends on both physico-chemical nature of the environment as well as the biological peculiarities of the organisms themselves. The infinite variety of such patterns that occurs in nature can be roughly grouped under three categories (i) uniform or regular distribution where the individuals are evenly spaced in the community (ii) random or chance of occurence where the individuals are scattered in some places and grouped at others (iii) clumped distribution where the individuals always occur in groups and are rarely seen individually spaced apart.

(a) Morista's index

Morista's indices of dispersion have the advantage of being relatively independent of the type of distribution, the number of samples and the size of the mean. The calculated value of Morista's index exhibits a total value of 1.707 $\pm$ 0.31, 1.545 $\pm$ 0.25 and 1.771 $\pm$ 0.36 respectively to premonsoon, monsoon and post-monsoon (Table 18)

According to Morista's index, when the value of the index is one, it indicates a random distribution, when the value of the index is more than one the distribution is clumped or aggregated. When the distribution is uniform or regular, the index will be less than one. Here all the values are above 1 which indicated that the distribution of vegetation is almost aggregated or clumped during all seasons. The intertidal part of station 1 shows higher index of 2.05 (premonsoon) and 2.27 (postmonsoon) and subtidal part of station 3 (premonsoon) shows 2.20 which means the aggregation is very high.

b. Statistical distribution

Since some statistical model can be conveniently used to describe the distribution of aggregation in space, here the Poisson series has been used to evaluate the pattern of the distribution (Table 19). According to Poisson distribution, when the variance S^2 is equal to the mean, the distribution confirm to the Poisson series and is therefore random. If the variance is less than the mean a regualr or uniform distribution is implied. When the variance is larger than the mean, the distribution is said to be clumped or

TABLE - 18

SPECIES DISTRIBUTION

(MORISTA'S INDEX)

St. No	TIDAL PART	PRE-MONSOON	MONSOON	POST-MONSOON
1	Inter Tidal	2·05	1·57	2·27
	Sub Tidal	1·56	1·24	1·46
2	Inter Tidal	1·53	1·81	1·97
	Sub Tidal	1·88	1·18	1·46
3	Inter Tidal	1·97	1·65	2·28
	Sub tidal	2·20	1·53	1·33
4	Inter Tidal	1·75	1·36	1·96
	Sub Tidal	1·28	1·89	1·48
5	Inter tidal	1·47	1·40	1·49
	Sub Tidal	1·38	1·82	2·01
	AVERAGE & Sd.	1.707± 0.31	1.545± 0.25	1.771± 0.36

TABLE - 19

STATISTICAL DISTRIBUTION (POISSON) OF SEAWEEDS

St. No	TIDAL PART	PRE MONSOON		MONSOON		POST MONSOON	
		Mean	Sd	Mean	Sd	Mean	Sd
1	Inter Tidal	46.30	1592.84	34.83	1212.95	68.79	4731.93
	Sub Tidal	34.10	668.29	26.74	95.76	31.36	356.96
2	Inter Tidal	34.03	637.58	47.63	1503.70	26.65	626.38
	Sub Tidal	33.47	838.37	25.47	75.27	32.78	518.79
3	Inter Tidal	49.25	1657.23	47.37	1325.00	45.32	2382.69
	Sub tidal	28.26	906.51	53.82	1502.20	31.48	727.84
4	Inter Tidal	31.48	727.84	24.30	197.88	40.56	1564.09
	Sub Tidal	25.51	217.11	42.68	1079.80	42.71	777.45
5	Inter tidal	27.15	332.50	32.59	290.67	33.75	537.28
	Sub Tidal	21.46	159.60	40.58	892.46	53.10	2729.78
	AVERAGE & Sd. $\pm$	33.10 8.77	773.79 514.97	37.60 10.37	817.57 592.67	40.65 12.69	1495.32 1407.06

aggregated. Here in all the stations the S^2 (variance) higher than the m (mean) and therefore confirm that the seaweed vegetation of South Andaman is under grouped or aggregated.

4.3.2 COMMUNITY LEVEL

Individual organisms and the population formed by them live as an assemblage of species population in any given area forming a community. These are (1) seral species occur in the same area, (ii) it is possible to recognise a community type since the same group of species with a more or less constant composition occur in space and time and (iii) communities tend to establish a dynamic stability. Any disturbance in this steady state tends to be set right by self-regulation, or homeostasis. Here (1) the results of community structure in the form of phytosociograph has been represented to know the position of the seaweed communities during the season. (2) The community composition has been represented by the diversity results to know the relationship between the number of species and individuals. (3) The community comparison has been analysed with the help of similarity index to understand the comparative position of seaweeds in both tidal parts of all stations during the three different seasons.

(a) Community structure (IVI and Phytograph)

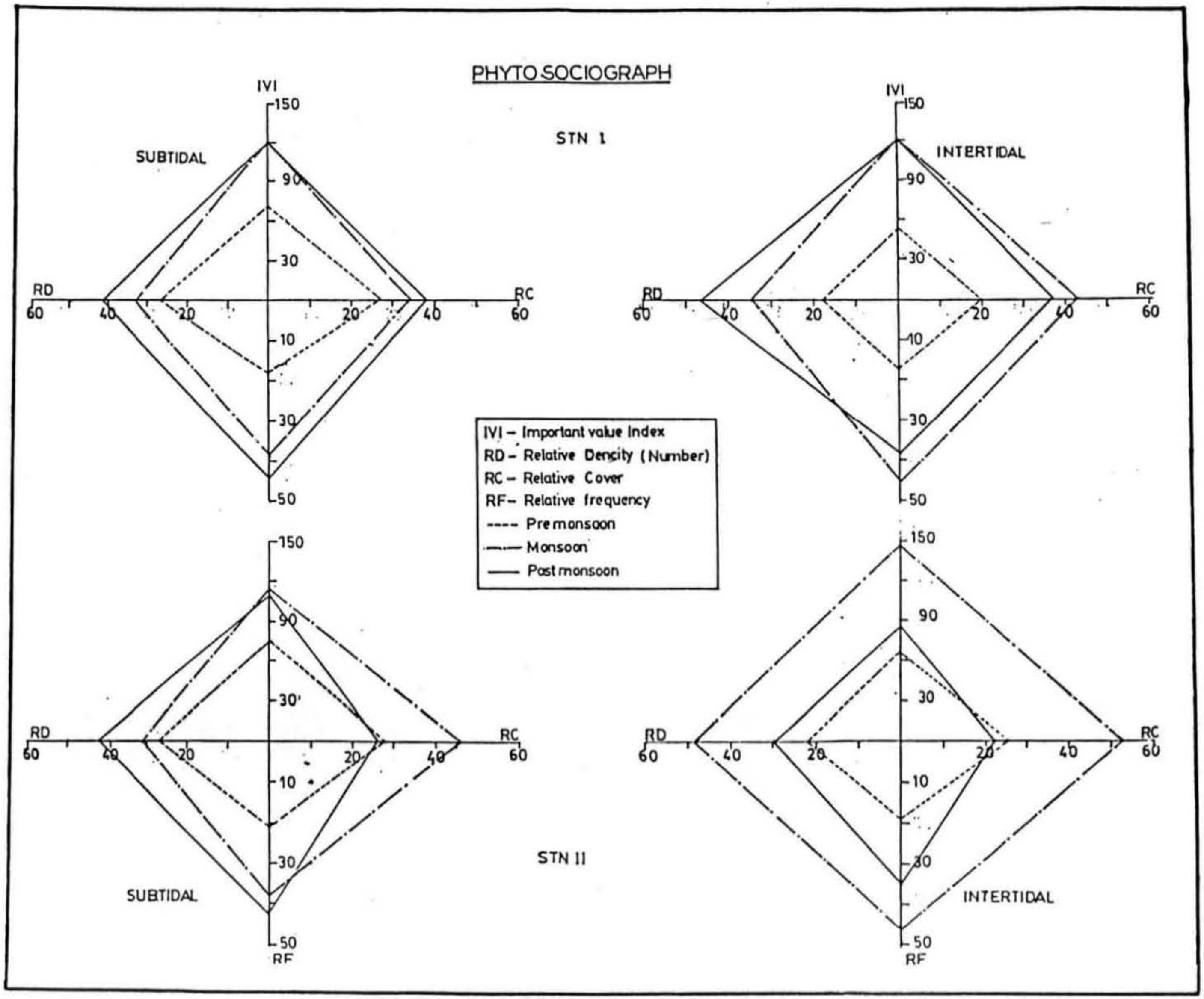
In any community structure, the quantitative value of each of the frequency, density, abundance and cover has its own importance. In order to have a real overall picture of ecological importance of a species with respect to the community structure, the percentage values of the relative frequency, relative density (biomass) and relative coverage are added together and this value out of 300 is called the important value index or IVI of the species. With help of divided circle phytographic method called phytograph has been drawn for both tidal parts for all 5 stations in three seasons by using above said important value indices (IVI) which give the nature of sociological structure of community and the dimension of relative values of frequency, density and coverage. Such illustrations are presented in (Fig. 19a, b and c) for two tidal parts of all 5 stations to understand the deviations in community structure during the different seasons.

The seaweed species which form community in the interdial and subtidal parts of station I are presented in the figure (19 a). Here the small dashes explain the community structure of premonsoon, long dashes for monsoon and lines for postmonsoon. In intertidal part, the relative values of frequency and cover increase from premonsoon to monsoon and again it reduces below the monsooon values, during postmonsoon. But in the case of density (Biomass) shows gradual increment and IVI stands nearly equal during monsoon and postmonsoon. The IVI values during premonsoon, monsoon and postmonsoon are 70, 120 and 120 respectively. The subtidal part exhibits almost gradual increment in all relative values from premonsoon to postmonsoon. The IVI values show 70 at premonsoon and 120 for both monsooon and post monsoon. Therefore it can be inferred that the community structure of station I has almost the same vegetation in both tidal parts.

In station II which has been presented in the figure (19 a), exhibits a totally different structure, it increases from premonsoon to monsoon, but in postmonsoon again it reduces, the community structure stands between the premonsoon and monsoon values and notably the relative cover value of post-monsoon data reduces even lesser than premonsoon data. The IVI values clearly express the deviation by the index value of 65 in premonsoon, 145 in monsoon and 85 during postmonsoon in intertidal part. On the otherhand the subtidal part represents a community structure of gradual increment in the relative values of density (biomass) and frequency. But in relative cover like intertidal part, the postmonsoon data again reduces even below the premonsoon value. The IVI values show the

FIGURE - 19a

Seaweed Community Structure in Different Seasons (St.I & II)



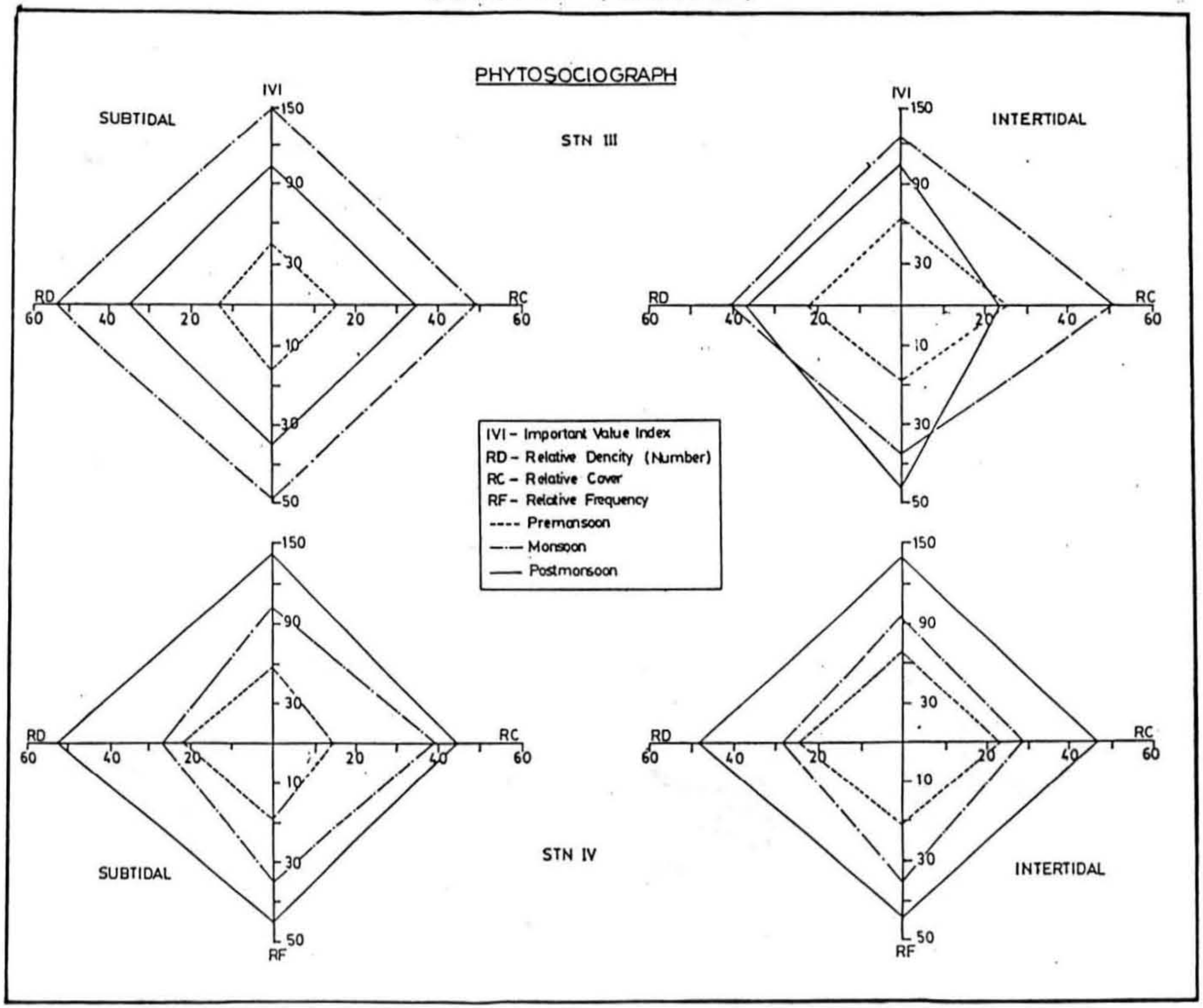
community sturcture that, there is a remarkable difference in all three seasons, the values are 75-100-110 during premonsoon, monsoon and postmonsoon respectively.

In station III (Fig. 19b) the community structure has good increment from premonsoon to monsoon, except during postmonsoon where the values touch almost near or below the level of premonsoon for relative level of monsoon data. But the relative cover of intertidal part has gradual increment from premonsoon to monsoon and the IVI values of 60-125-100 indicate fluctuation from monsoon to postmonsoon. The community structure of subtidal part shows remarkable differences with positive increment in all relative values and the IVI has the values of 45-150-105 during premonsoon, monsoon and postmonsoon respectively, since the mangroves almost dominate in the intertidal part in station III, it affects the community structure of the seaweeds during all seasons especially during postmonsoon.

In station IV (Fig. 19b) both tidal parts show clear cut improved values from premonsoon to postmonsoon. The IVI shows 70-95-140 for Intertidal part and 60-100-140 for subtidal part. It may be assumed that here competition for survival of the species against its requirement is not much and remarkable increment in the relative density supports the above said reason.

FIGURE - 19b

Seaweed Community Structure in Different Seasons (St. III & IV)

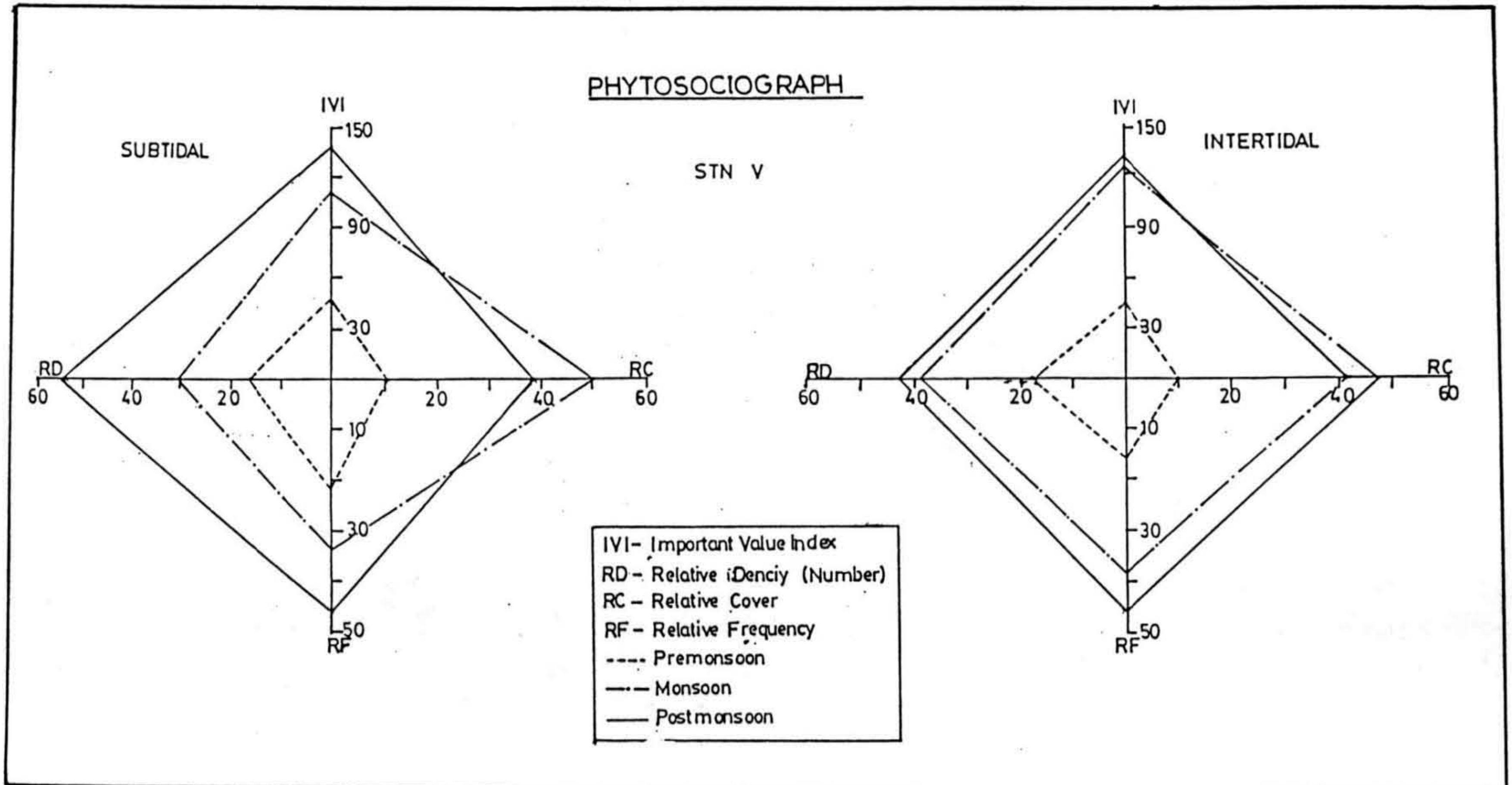


In station V (Fig. 19c) also both the tidal parts have almost same community structure during three seasons. But like other cases here in the subtidal part, the relative cover value of the postmonsoon is lower when compared to the monsoon. The IVI values of interdial part are 45-120-130 and for subtidal part are 45-110-135 for premonsoon, monsoon and postmonsoon respectively.

To conclude when we consider the relative density, all parts except the intertidal parts of station II and III, have the gradual increment from premonsoon to postmonsoon period in all stations. Since, the density (biomass) increases according to plant growth it can be unidirectional with gradual increment in weight. But the exception comes when the plants undergo remarkable mortality, and stunted in growth because of competition for the nutrients and subtratum availability. Here the intertidal parts of station II & III (Burmanala and Cheriadapu) are totally covered by mangroves in most of the regions, are the prime factors that affect the seaweed growth. The mangrove causes problems by making the environment with nutrient scarcity, muddy bottom and also oxygen deficiency. So automatically these affect the seaweed growth in the parts of intertidal in these two stations. The rest of the intertidal parts and all subtidal parts show that normally the density has gradual increment in values because of growth.

FIGURE - 19c

Seaweed Community Structure in Different Seasons (St. V)



The plant cover which can be increased by the growth of species in the community will be affected at the same time by mortality during earlier and middle of the growth period. If the mortality is higher during the middle of the growth it affects considerably. This is clear in the intertidal part of station I and II. Chances of increased mortality is more in station I, (college area) and in Burmanala due to civilization and abundance of mangrooves. The station II, which is affected by both mangroves and civilization near the shore shows more reduced value than the college area (ST.I)

Finally the frequency which has more fluctuation is considered. While comparing the frequency values of monsoon season with that of postmonsoon the values come down in both tidal parts of station II and V, and in intertidal part of Station I and III. So the frequency is the prime factor here to define the community structure. Since frequency deals with the number of species and its occurence, it varies always, because, the mortality at first affects the frequency level. But according to pattern of distribution results in South Andaman almost the vegetation is aggregated or clustered in distribution. So that it can be concluded that the cluster having numerous species with little mortality may not change more in frequency value. But if the cluster contains only few species and due to the influence of the dominant species of that region, considerable mortality will result. Since the cluster contains only few species it affects the frequency values considerably. Considering this in Station II and V the cluster is with only few number of the species in both tidal parts, and in station V the competition is more because of more number of species. The intertidal part of station I has the more mortality because of shore near civilization whereas it is because of mangrooves in Station III.

So in South Andaman the seaweed community structure is mainly affected by frequencey (numerical strength), followed by cover and density. Almost the intertidal and subtidal parts have same community structure in most of the stations except the intertidal parts affected by mangrooves and civilization.

(b) **Community Composition**

The diversity which is termed as the ratio between the number of species and the total number of individuals is considered for the community composition study and results are presentd in the tables (20 and 21). The Simpson's diversity is used to analyse the sub communities like seral and climax communities (on the basis of availability of species throughout all seasons) and agarophyte, alginophyte and other algae group sub communities (on the basis of economical importance). To know the individual species position in the total diversity level Shannon-Weaver diversity method is used and the results are presented in the table (21).

Simpson's diversity

The both tidal parts of the all 5 stations communities of different seasons, sub divided into above said five sub communities. The results of Simpson's diversity have been presented for all five sub communites and also for community as a whole (total community), (Table 20) Except few stations, the sub community of climax species (on the basis of availability of species) and the alginophytes (on the basis of economical importance) almost dominate in all stations. The intertidal parts of station IV and V support higher diversity values than other stations. In stations I, II & III, subtidal parts support high diversity values. The total community diversity supports higher values during the monsoon followed by postmonsoon and low in premonsoon, since the postmonsoon and monsoon have more number of species than premonsoon. For some seral species, the earlier growth starts during postmonsoon and monsoon. This reason can be attributed for getting more

TABLE - 20

SIMPSON'S DIVERSITY FOR DIFFERENT COMMUNITIES

Sl. No.	COMMUNITY COMPOSITION	INTERTIDAL-1			SUBTIDAL-1			INTERTIDAL-2			SUBTIDAL-2		
		Pre-Mon	Mon	Post-Mon	Pre Mon	Mon	Post-Mon	Pre-Mon	Mon	POST-Mon	Pre-Mon	Mon	Post-Mon
1	Diversity in Total	0.77	0.88	0.85	0.84	0.91	0.91	0.86	0.89	0.88	0.81	0.92	0.90
2	Seral Community	--	0.97	0.99	0.98	0.98	0.98	0.98	0.97	0.90	--	0.99	0.97
3	Climax Community	0.77	0.93	0.80	0.88	0.91	0.97	0.88	0.91	0.98	0.81	0.93	0.92
4	Agarophytes	--	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99
5	Alginophytes	0.98	0.97	0.99	0.99	0.94	0.98	0.98	0.94	0.98	0.96	0.96	0.97
6	Other Algae	0.79	0.73	0.86	0.89	0.95	0.93	0.89	0.95	0.90	0.87	0.96	0.93

Sl. No.	COMMUNITY COMPOSITION	INTERTIDAL-3			SUBTIDAL-3			INTERTIDAL-4			SUBTIDAL-4		
		Pre-Mon	Mon	Post-Mon	Pre-Mon	Mon	Post-Mon	Pre-Mon	Mon	Post-Mon	Pre-Mon	Mon	Post-Mon
1	Diversity in Total	0.83	0.92	0.87	0.78	0.99	0.91	0.85	0.93	0.90	0.88	0.89	0.92
2	Seral community	0.89	0.97	0.98	0.99	0.97	0.97	0.98	0.95	0.97	0.99	0.96	0.94
3	Climax community	0.83	0.95	0.90	0.79	0.95	0.94	0.87	0.96	0.93	0.89	0.93	0.98
4	Agarophytes	0.90	0.99	--	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99
5	Alginophytes	0.98	0.97	0.98	0.96	0.93	0.95	0.99	0.99	0.99	0.94	0.94	0.97
6	Other algae	0.85	0.94	0.90	0.82	0.98	0.95	0.88	0.95	0.92	0.93	0.94	0.95

Sl. No.	COMMUNITY COMPOSITION	INTERTIDAL-5			SUBTIDAL-5		
		Pre-Mon	Mon	Post-Mon	Pre-Mon	Mon	Post-Mon
1	Diversity in total	0.87	0.92	0.93	0.88	0.91	0.79
2	Seral community	0.97	0.98	0.98	0.99	0.99	0.90
3	Climax community	0.89	0.95	0.97	0.89	0.95	0.88
4	Agarophytes	0.99	0.99	0.99	0.99	0.99	0.99
5	Alginophytes	0.97	0.96	0.97	0.98	0.99	0.99
6	Other Algae	0.90	0.97	0.98	0.91	0.91	0.80

NOTE

1 Here Community in Total includes all populations in a Tidal part.

2 Seral & Climax communities and Agarophytes, Alginophytes and Other algae groups are considered as Sub communities respectively.

3 "--" Refers no vegetaion or negligible.

number of species, individuals and increased diversity index. Among the economical group alginophytes show higher diversity than the other algae and agarophytes. In general, the reason may be, since the agarophytes have lower number of species than alginophytes and other algae, it has low value of diversity index than others. But in case of other algae, eventhough it has more number of species than alginophtes, where the number of individuals play major role, it means the other algae group has more number of species than alginophytes and also less number of individuals than alginophytes. But the diversity deals with the ratio between the number of species and the total number of individuals, so automatically the alginophytes dominates than the other algae. And according to Simpon's diversity values the monsoon season gives remarkable support to sub community of seral species climax community. The reason may be that due to stability of all seasons the climax community has fewer number of species and fewer number of individuals, so it has almost lower diversity index than seral community which has a limited season for growth with numerous individuals which automatically dominates.

Shannon-Weaver diversity

The diversity index values have been presented in the table (21a, b and c). During the premonsoon season the

TABLE - 21a

SPECIESWISE SHANNON-WEAVER DIVERSITY

Sl. No.	SPECIES	STATION-1						STATION-2					
		INTERTIDAL			SUBTIDAL			INTERTIDAL			SUBTIDAL		
		Pre-Mon.	Mon.	Post-Mon	Pre-Mon.	Mon.	Post-Mon.	Pre-Mon.	Mon.	Post-Mon.	Pre-Mon.	Mon.	Post-Mon
1	(OA) *Enteromorpha compressa*	0.368	0.330	0.361									
2	*Ulva spp.*		0.088	0.116									
3	*Chaetomorpha antennina*			0.176					0.088	0.251			
4	*Cladaphora marina*												
5	*Caulerpa spp.*	0.163	0.117	0.085				0.226	0.179	0.150			
6	*Acetabularia calyculus*		0.278	0.311					0.274	0.357			
7	*Codium spp.*	0.117	0.146	0.062	0.121	0.090	0.126	0.146	0.071	0.130	0.196	0.232	0.152
8	*Halimeda spp.*	0.353	0.232	0.238	0.362	0.134	0.187	0.357	0.272	0.172	0.367	0.266	0.319
9	*Valoniopsis pachynema*					0.242	0.320			0.102			0.236
10	*Ectocarpus siliculosus*							0.259	0.187				
11	*Dictyota dichotoma*		0.125	0.107		0.175	0.077		0.071			0.057	0.142
12	*Hydroclathrus clathratus*												
13	*Amphiroa spp.*				0.213	0.214	0.199				0.106	0.232	0.230
14	*Jania rubens*					0.259	0.267						
15	*Grateloubia spp.*										0.202	0.120	0.137
16	*Hypnea spp.*								0.100	0.095		0.184	0.077
17	*Galaxaura oblongata*							0.164		0.095			
18	*Ceramium avalona*								0.075	0.125			
19	*Laurencia papilosa*												
20	(AL) *Padina tetrastomatica*												
21	*P. gymnospora*	0.240	0.092	0.130	0.277	0.222	0.121	0.222	0.096	0.135	0.313	0.179	0.084
22	*Sargassum ilicifolium*	0.124	0.117	0.095	0.185	0.214	0.142	0.140	0.052	0.185	0.177	0.232	0.063
23	*S. myriosystem*												
24	*S. duplicatum*											0.173	0.230
25	*S. tennerium*		0.232			0.222	0.175					0.184	
26	*S. wightii*	0.123	0.117	0.146	0.112	0.121	0.248	0.127	0.172	0.075	0.133	0.134	0.267
27	*Turbinaria conoides*	0.117	0.236	0.101	0.159	0.159	0.152	0.140	0.336	0.159	0.115	0.167	0.183
28	*T. ornata*	0.169	0.153	0.119	0.208	0.053	0.230	0.170	0.189	0.075	0.106	0.224	0.121
29	*T. turbinata*				0.197					0.200			
30	(AG) *Gelidium heteroplatos*			0.146	0.246	0.141	0.045	0.241	0.172	0.145	0.243	0.155	0.183
31	*Gelidiella acerosa*		0.063	0.070			0.137		0.100				
32	*Gracilaria corticata*				0.259								
33	*G. crassa*												
34	*G. edulis*												
35	*G. folifera*												
	TOTAL	1.775	2.326	2.263	2.080	2.505	2.426	2.152	2.434	2.451	1.958	2.539	2.423
	NUMBER OF SPECIES	9	14	15	10	14	14	11	16	16	10	14	14

TABLE - 21b

SPECIESWISE SHANNON-WEAVER DIVERSITY

Sl. No.	SPECIES	STATION-3						STATION-4					
		INTERTIDAL			SUBTIDAL			INTERTIDAL			SUBTIDAL		
		Pre-Mon.	Mon.	Post-Mon	Pre-Mon.	Mon.	Post-Mon.	Pre-Mon.	Mon.	Post-Mon.	Pre-Mon.	Mon.	Post-Mon
1	(OA)*Enteromorpha compressa*	0.366	0.238	0.357				0.362	0.228	0.325			
2	*Ulva spp.*		0.099	0.145					0.083	0.157			
3	*Chaetomorpha antennina*								0.150	0.123			
4	*Cladaphora marina*							0.127					
5	*Caulerpa spp.*	0.212	0.048	0.070									
6	*Acetabularia calyculus*		0.292	0.249									
7	*Codium spp.*							0.133	0.201	0.099	0.196	0.110	0.100
8	*Halimeda spp.*	0.316	0.241	0.139	0.365	0.215	0.287	0.241	0.136	0.275	0.335	0.255	0.170
9	*Valoniopsis pachynema*			0.017									
10	*Ectocarpus siliculosus*							0.254	0.271				
11	*Dictyota dichotoma*		0.125										
12	*Hydroclathrus clathratus*					0.046	0.106					0.115	0.126
13	*Amphiroa spp.*				0.187	0.054	0.167				0.176	0.128	0.193
14	*Jania rubens*		0.066	0.134		0.058	0.234		0.119	0.182		0.110	0.212
15	*Grateloubia spp.*				0.153	0.054					0.120	0.101	
16	*Hypnea spp.*		0.099	0.133		0.091	0.102						
17	*Galaxaura oblongata*	0.115		0.106									
18	*Ceramium avalona*								0.177	0.103			
19	*Laurencia papilosa*	0.161	0.041	0.098				0.145	0.069	0.050	0.208	0.030	0.088
20	(AL)*Padina tetrastomatica*		0.249	0.153		0.080	0.206		0.228	0.242		0.302	0.290
21	*P. gymnospora*	0.271	0.048	0.162	0.276	0.290	0.146	0.190	0.211	0.068	0.267	0.313	0.054
22	*Sargassum ilicifolium*	0.109	0.074	0.083	0.179	0.226	0.106	0.145	0.102	0.034	0.028	0.273	0.088
23	*S. myriosystem*	0.136	0.081	0.123	0.153	0.176	0.273	0.156	0.076	0.034	0.161	0.086	0.126
24	*S. duplicatum*					0.273	0.106			0.163			0.265
25	*S. tennerium*					0.159							
26	*S. wightii*	0.120	0.164	0.257	0.179	0.127	0.151	0.107	0.119	0.165	0.196	0.140	0.193
27	*Turbinaria conoides*	0.090	0.227	0.070	0.134	0.184	0.203						
28	*T. ornata*	0.120	0.259	0.087	0.153	0.111	0.144						
29	*T. turbinata*			0.083		0.159	0.266		0.185	0.160		0.166	0.170
30	(AG)*Gelidium heteroplatos*		0.163					0.219	0.096	0.080		0.063	
31	*Gelidiella acerosa*								0.185	0.050		0.086	0.074
32	*Gracilaria corticata*							0.139	0.083	0.157	0.208	0.063	0.175
33	*G. crassa*				0.134	0.122	0.118				0.208	0.115	0.175
34	*G. edulis*							0.076			0.060		
35	*G. folifera*							0.064			0.112		
	TOTAL	2.070	2.514	2.47	1.913	2.537	2.550	2.218	2.491	2.607	2.283	2.456	2.518
	NUMBER OF SPECIES	11	17	18	10	17	15	12	18	20	11	18	18

TABLE - 21c

SPECIESWISE

SHANNON-WEAVER DIVERSITY

Sl. No.	SPECIES	STATION-5					
		INTERTIDAL			SUBTIDAL		
		Pre-MOn.	Mon.	Post-Mon.	Pre-Mon.	Mon.	Post-Mon.
1	(OA)*Enteromorpha compressa*						
2	*Ulva spp.*						
3	*Chaetomorpha antennina*						
4	*Cladaphora marina*	0.170		0.075			0.090
5	*Caulerpa spp.*		0.123				
6	*Acetabularia calyculus*						
7	*Codium spp.*						
8	*Halimeda spp.*	0.349	0.211	0.168	0.339	0.207	0.337
9	*Valoniopsis pachynema*		0.200	0.182		0.092	0.226
10	*Ectocarpus siliculosus*	0.282	0.161		0.248		
11	*Dictyota dichotoma*		0.161	0.162		0.216	0.160
12	*Hydroclathrus clathratus*			0.174		0.092	0.059
13	*Amphiroa spp.*				0.233	0.169	0.199
14	*Jania rubens*		0.083	0.075		0.154	0.192
15	*Grateloubia spp.*						
16	*Hypnea spp.*		0.213	0.055		0.081	0.105
17	*Galaxaura oblongata*						
18	*Ceramium avalona*		0.083	0.101			0.343
19	*Laurencia papilosa*	0.207	0.193	0.140	0.218	0.300	0.343
20	(AL)*Padina tetrastomatica*						
21	*P. gymnospora*	0.252	0.213	0.088	0.194	0.081	0.162
22	*Sargassum ilicifolium*	0.201	0.127	0.275	0.127	0.137	0.099
23	*S. myriosystem*	0.064	0.183		0.109	0.068	
24	*S. duplicatum*			0.147			
25	*S. tennerium*						
26	*S. wightii*	0.148	0.083	0.267	0.144	0.092	0.144
27	*Turbinaria conoides*	0.196	0.291	0.144	0.160	0.068	0.093
28	*T. ornata*	0.177	0.097	0.101	0.194	0.177	0.043
29	*T. turbinata*						
30	(AG)*Gelidium heteroplatos*						
31	*Gelidiella acerosa*		0.123	0.101		0.092	0.090
32	*Gracilaria corticata*	0.148	0.107	0.092	0.206	0.068	0.019
33	*G. crassa*			0.179	0.160	0.154	0.087
34	*G. edulis*			0.075			0.096
35	*G. folifera*			0.101			0.059
	TOTAL	2.194	2.713	2.839	2.332	2.567	3.107
	NUMBER OF SPECIES	11	18	21	12	18	21

moderate range of diversity index of 1.78 to 2.33 has been recorded for all stations. The monsoon and postmonsoon show nearly higher diversity of 2.33 to 2.71 and 2.08 to 3.1 respectively. In general the maximum values of the total diversity index for all 5 stations both tidal parts, eventhough they have difference in species, are almost similar. The monsoon and postmonsoon support more number of species and individuals too.

(c) Community Comparison (Tables 22-26)

The results of relative similarities between all 5 stations during the three seasons, which are considered for the study of community comparison, has been presented into different tables. The tables consider the following details respectively (1) comparison within the system (2) comparison between the systems (3) comparison between the intertidal parts (4) comparison between the subtidal parts and (5) comparison between subtidal and intertidal parts. The data of common and uncommon species between the comparing system is analysed to get index of similarity and quotient similarity.

Here the index of similaity considers the real value of common species and it is always higher in number than the uncommon species, and it positively increases when common species are higher in number than uncommon species.

In general, the index of similarity have high value when the difference between the common and uncommon species is higher. Here the values of similarity index of more than one is also considered as 1 (100%).

In the first level of comparison which considers the comparison between the stations exhibit almost 100% similarites except in station II, where the premonsoon has only 33% of similarities. So this result also supports the view of community structure of all stations where the intertidal part and subtidal part of all stations show almost same species during all three seasons.

The relative similarity of comparison between systems (stations) show the total value of 28% to 100% during premonsoon, 15% to 62% during monsoon and 12% to 61% during postmonsoon. It can be understood that the number of uncommon species slowly increase from the premonsoon to postmonsoon and in postmonsoon it shows the lowest similarity index. In case of the comparison between the intertidal parts which exhibits a value of 55% - 100% during premonsoon, 25% to 100% during monsoon and 23%-100% during postmonsoon show almost 100% similarities in almost all seasons and the range inceases from premonsoon to postmonsoon. The 100% similarity during all seasons has been recorded in almost all in 2nd level comparison and few in

TABLE -22

COMMUNITY COMPARISON

1 • COMPARISON WITHIN THE SYSTEMS

No.	SYSTEM	PREMONSOON				MONSOON				POST MONSOON			
		Common-Species	Un Common Species	Relative Similarity		Common Species	Un-common Species	Relative Similarity		Common Species	Un-common Species	Relative Similarity	
				Index	Quotient			Index	Quotient			Index	Quotient
1	I	7	5	2.80	-3.50	9	10	1.80	9.00	10	9	2.20	-10.00
2	II	8	5	0.33	-2.67	10	10	2.00	0.00	10	10	2.00	0.00
3	III	7	6	2.33	-7.00.	10	14	1.43	2.50	11	11	2.00	0.00
4	IV	8	7	2.90	-8.00	13	9	2.89	-3.25	14	10	2.40	-3.5
5	V	10	10	6.67	-1.43	15	6	5.00	-1.67	20	2	20.00	-1.10

TABLE - 23

COMMUNITY COMPARISON

2 • COPARISON BETWEEN THE SYSTEMS (Stations)

No	SYSTEM	PREMONSOON				MONSOON				POST MONSOON			
		Common-Species	Un Common Species	Relative Similarity		Common Species	Un-common Species	Relative Similarity		Common Species	Un-common Species	Relative Similarity	
				Index	Quotient			Index	Quotient			Index	Quotient
1	AB	7	12	1.17	1.40	8	26	0.62	0.44	8	27	0.59	0.42
2	AC	6	15	0.80	0.67	6	38	0.32	0.19	6	38	0.32	0.19
3	AD	5	22	0.46	0.29	5	43	0.23	0.13	5	47	0.21	0.12
4	AE	6	18	0.67	0.50	7	36	0.39	0.24	8	39	0.41	0.20
5	BC	6	15	0.80	0.67	6	40	0.30	0.18	7	35	0.40	0.25
6	BD	5	24	0.42	0.26	6	41	0.29	0.17	4	52	0.15	0.08
7	BE	6	20	0.60	0.43	8	34	0.47	0.31	7	44	0.32	0.19
8	CD	5	23	0.43	0.28	7	41	0.34	0.21	8	39	0.41	0.36
9	CE	7	15	0.93	0.88	9	34	0.53	0.36	9	39	0.46	0.30
10	DE	7	18	0.78	0.64	9	35	0.51	0.35	11	36	0.61	0.44
11	ABC	6	24	0.75	0.33	6	58	0.31	0.12	6	52	0.35	0.13
12	ABD	5	28	0.54	0.22	5	63	0.23	0.09	4	73	0.16	0.06
13	ABE	6	27	0.67	0.29	7	52	0.40	0.16	6	65	0.28	0.10
14	ACD	4	38	0.32	0.12	4	73	0.16	0.06	4	76	0.16	0.06
15	ACE	6	26	0.69	0.30	6	62	0.29	0.11	6	68	0.27	0.10
16	ADE	4	41	0.29	0.11	4	75	0.16	0.06	4	85	0.14	0.07
17	BCD	4	40	0.30	0.11	4	75	0.16	0.06	4	77	0.16	0.06
18	BCE	6	28	0.64	0.28	7	68	0.31	0.12	7	36	0.33	0.13
19	BDE	4	43	0.28	0.13	4	77	0.16	0.06	4	86	0.14	0.05
20	CDE	5	36	0.42	0.16	7	63	0.33	0.07	6	77	0.23	0.09
21	ABCD	4	51	0.31	0.09	4	95	0.17	0.04	4	98	0.16	0.04
22	ABCE	6	35	0.69	0.21	6	80	0.30	0.08	6	86	0.28	0.08
23	ABDE	4	54	0.30	0.08	4	99	0.16	0.04	4	107	0.15	0.04
24	ACDE	4	53	0.30	0.82	4	101	0.16	0.04	4	110	0.15	0.04
25	BCDE	4	54	0.30	0.08	4	103	0.16	0.04	4	111	0.14	0.04
26	ABCDE	4	61	0.30	0.07	4	123	0.16	0.03	4	132	0.12	0.03

A = System-I . B = System-II C = System-III D = System-IV E = System-V

3rd level comparison. Comparing to intertidal part the subtidal part shows better range in almost all three seasons ie. 90 to 100% similarity during premonsoon, 44 to 100% during monsoon and 42 to 100% during postmonsoon. Here even in postmonsoon the 4th level comparison shows 100% relative similarity index. But at last when we consider the comparison between the intertidal parts as a whole (Table 24), it represents 60% similarity at premonsoon, 16% at monsoon and 3% at postmonsoon. It can be concluded that the different stations have their own type of species, and the common species has a number of 4 during all three seasons but the uncommon species increases from 66-123-132 during premonsoon, monsoon and postmonsoon respectively.

4.4 SEAWEEDS AND ENVIRONMENTAL FACTORS

The relative ecological position of the species against environmental factors were analysed in two ways. (1) hierarchical cluster analysis and (2) Multiple regression. The results of cluster analysis have been represented to know the hierarchical distribution in the form of numerical distance of seaweed species in different seasons and the results of multiple regression are presented to show significant relationship in the form of positive or negative correlation between the forcing factors and the seaweeds.

TABLE - 24

COMMUNITY COMPARISON

3 • COMPARISON BETWEEN INTERTIDAL PARTS

No	Intertidal parts	PREMONSOON				MONSOON				POST MONSOON			
		Common Species	Un-Common Species	Relative Similarity Index	Relative Similarity Quotient	Common Species	Un-common Species	Relative Similarity Index	Relative Similarity Quotient	Common Species	Un-common Species	Relative Similarity Index	Relative Similarity Quotient
1	AB	8	4	4.00	-2.00	10	10	2.00	0.00	11	9	2.44	-5.33
2	AC	8	4	4.00	-2.00	11	9	2.44	-5.50	10	13	1.53	3.33
3	AD	6	9	1.33	2.00	8	16	1.00	1.00	10	15	1.33	2.00
4	AE	7	6	2.33	-7.00	10	12	1.67	5.00	8	20	0.80	0.67
5	BC	8	6	2.67	-4.00	11	11	2.00	0.00	12	10	2.40	-6.00
6	BD	7	9	1.56	3.50	10	14	1.43	2.50	9	18	0.50	1.00
7	BE	6	10	1.20	1.50	11	12	1.83	11.00	9	19	0.95	0.90
8	CD	7	9	1.56	3.50	11	13	1.69	5.50	12	14	1.71	6.00
9	CE	8	6	2.67	-4.00	13	9	2.89	3.25	11	17	1.29	1.33
10	DE	9	5	3.60	-2.25	12	14	1.71	6.00	13	15	1.73	6.50
11	ABC	7	10	2.10	2.33	9	20	1.35	0.82	8	25	0.96	0.47
12	ABD	5	17	0.88	0.42	5	33	0.46	0.18	7	30	0.70	0.30
13	ABE	6	13	1.39	0.86	7	27	0.78	0.35	6	34	0.53	0.21
14	ACD	5	17	0.88	0.42	6	31	0.58	0.24	7	32	0.66	0.28
15	ACE	6	13	0.92	0.86	8	33	0.73	0.32	6	36	0.50	0.20
16	ADE	4	21	0.57	0.24	5	35	0.43	0.17	5	39	0.39	0.15
17	BCD	4	13	0.92	0.44	5	36	0.42	0.16	5	39	0.39	0.15
18	BCE	6	15	0.80	0.67	9	24	1.13	0.60	8	31	0.77	0.35
19	BDE	5	19	0.79	0.36	4	39	0.31	0.11	4	40	0.30	0.11
20	CDE	6	16	1.13	0.60	8	29	0.83	0.38	7	38	0.55	0.23
21	ABCD	4	27	0.59	0.17	3	53	0.23	0.06	4	53	0.30	0.08
22	ABCE	6	18	1.33	0.50	7	37	0.57	0.19	6	46	0.52	0.15
23	ABDE	4	27	0.59	0.17	4	50	0.32	0.09	4	56	0.29	0.08
24	ACDE	4	27	0.59	0.17	4	51	0.31	0.09	4	58	0.28	0.07
25	BCDE	4	29	0.55	0.16	4	53	0.30	0.08	4	59	0.27	0.07
26	ABCDE	4	34	0.74	0.13	4	63	0.25	0.07	4	70	0.23	0.06

A = IT of System-I B = IT of System-II C = IT of System-III D = IT of System-IV

E = IT of System-V (IT = Intertidal part)

TABLE - 25

COMMUNITY COMPARISON

4 • COMPARISON BETWEEN SUBTIDAL PARTS

NO	Sub-tidal Parts	PREMONSOON				MONSOON				POST MONSOON			
		Common-Species	Un Common Species	Relative Similarity		Common Species	Un-common Species	Relative Similarity		Common Species	Un-common Species	Relative Similarity	
				Index	Quotient			Index	Quotient			Index	Quotient
1	AB	9	2	9.00	-1.29	11	6	3.67	-2.20	11	6	3.67	-2.20
2	AC	7	5	2.80	-3.50	9	13	1.39	2.25	8	13	1.23	1.60
3	AD	6	9	1.33	2.00	9	13	1.39	2.25	8	16	1.00	1.00
4	AE	7	8	1.75	7.00	11	10	2.20	-11.00	11	13	1.69	5.50
5	BC	6	8	1.50	3.00	11	9	2.44	5.50	8	13	1.23	1.60
6	BD	7	7	2.00	0.00	7	17	0.82	0.70	7	18	0.78	0.64
7	BE	7	8	1.75	7.00	9	14	1.29	1.80	10	15	1.33	2.00
8	CD	7	6	2.33	-7.00	12	10	2.40	-6.00	12	9	2.67	-2.40
9	CE	8	5	3.20	-2.67	13	9	2.84	-3.25	12	12	2.00	0.00
10	DE	9	5	3.60	-2.25	13	9	2.89	-3.25	14	11	2.55	-4.67
11	ABC	6	11	1.64	1.20	7	24	0.88	0.41	7	22	0.96	0.47
12	ABD	6	13	1.39	0.86	7	24	0.88	0.41	5	31	0.48	0.19
13	ABE	7	11	1.91	1.75	8	22	1.09	0.57	9	29	0.93	0.32
14	ACD	5	15	1.00	0.50	6	30	0.60	0.25	6	29	0.62	0.32
15	ACE	7	10	2.10	2.33	8	24	1.00	0.50	9	23	1.17	0.64
16	ADE	5	18	0.83	0.39	6	31	0.58	0.40	7	32	0.66	0.28
17	BCD	6	12	1.50	1.00	6	30	0.60	0.25	5	32	0.47	0.19
18	BCE	7	10	2.10	2.33	8	25	0.96	0.47	7	29	0.72	0.32
19	BDE	5	18	0.83	0.39	5	34	0.44	0.17	5	38	0.40	0.15
20	CDE	6	14	1.30	0.75	10	22	1.36	0.83	9	27	1.00	0.50
21	ABCD	5	20	1.00	0.33	5	42	0.48	0.14	5	41	0.40	0.14
22	ABCE	7	13	2.15	1.17	6	39	0.62	0.18	7	36	0.78	0.24
23	ABDE	5	23	0.87	0.28	5	43	0.47	0.13	5	47	0.43	0.12
24	ACDE	5	22	0.91	0.29	5	46	0.44	0.12	5	48	0.42	0.12
25	BCDE	5	22	0.91	0.29	5	46	0.44	0.12	5	48	0.42	0.12
26	ABCDE	5	27	0.93	0.23	5	55	0.46	0.10	5	57	0.44	0.10

A = ST of System-I B = ST of System-II C = ST of System-III D = ST of System-IV

E = ST of System-V (ST = Subtidal part)

TABLE - 26

COMMUNITY COMPARISON

5 • COMPARISON BETWEEN INTERTIDAL AND SUBTIDAL PARTS

No.	SYSTEM	PREMONSOON				MONSOON				POST MONSOON			
		Common-Species	Un Common Species	Relative Similarity		Common Species	Un-common Species	Relative Similarity		Common Species	Un-common Species	Relative Similarity	
				Index	Quotient			Index	Quotient			Index	Quotient
1	1	4	66	0.61	0.07	4	123	0.162	0.03	4	132	0.12	0.03

4.4.1 Hierarchical cluster analysis

The relative ecological positions of the species with respect to environmental factors are estimated simultaneously using agglomerative hierarchical cluster analysis (Norusis, 1986), and the results are presented in the form of dendrogram for both the tidal parts separately and combined results during 3 seasons are tabulated. Here the species of all stations in South Andaman are grouped together for convenience. Because of the dissimilar units of the respective parameters, mean values for each species and parameters are tranformed into zero (0) scores, such that each parameter showed a mean of ′0' and a standard deviation of 1. Cluster are combined using average linkage between groups; squared distances formed the similarity measure for each variable. All parameters are weighed equally. The resulting dendrogram (Fig. 20-22) shows the relationship between species and species groups in the study area, with respect to mean values of the environmental parameters.

During the premonsoon season, the result of intertidal part shows two sub groups of species, Enteromorpha compressa and Halimeda spp. form a group and rest are grouped seperately (FIg. 20a). At the same time in the subtidal part the species have only one group with Halimeda spp. and Padina gymnospora in domination (Fig.

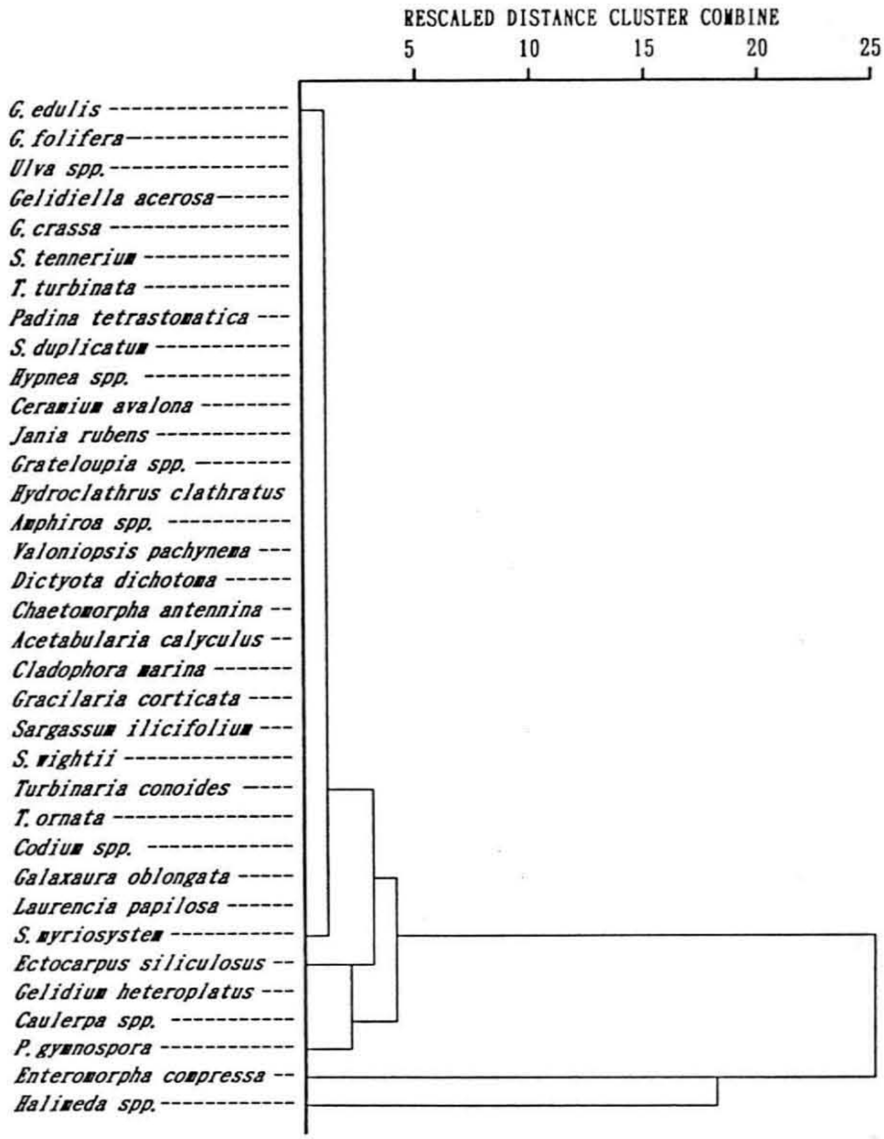


FIGURE - 20a

DENDROGRAM USING AVERAGE LINKAGE (BETWEEN GROUPS)

INTERTIDAL PART IN PREMONSOON SEASON

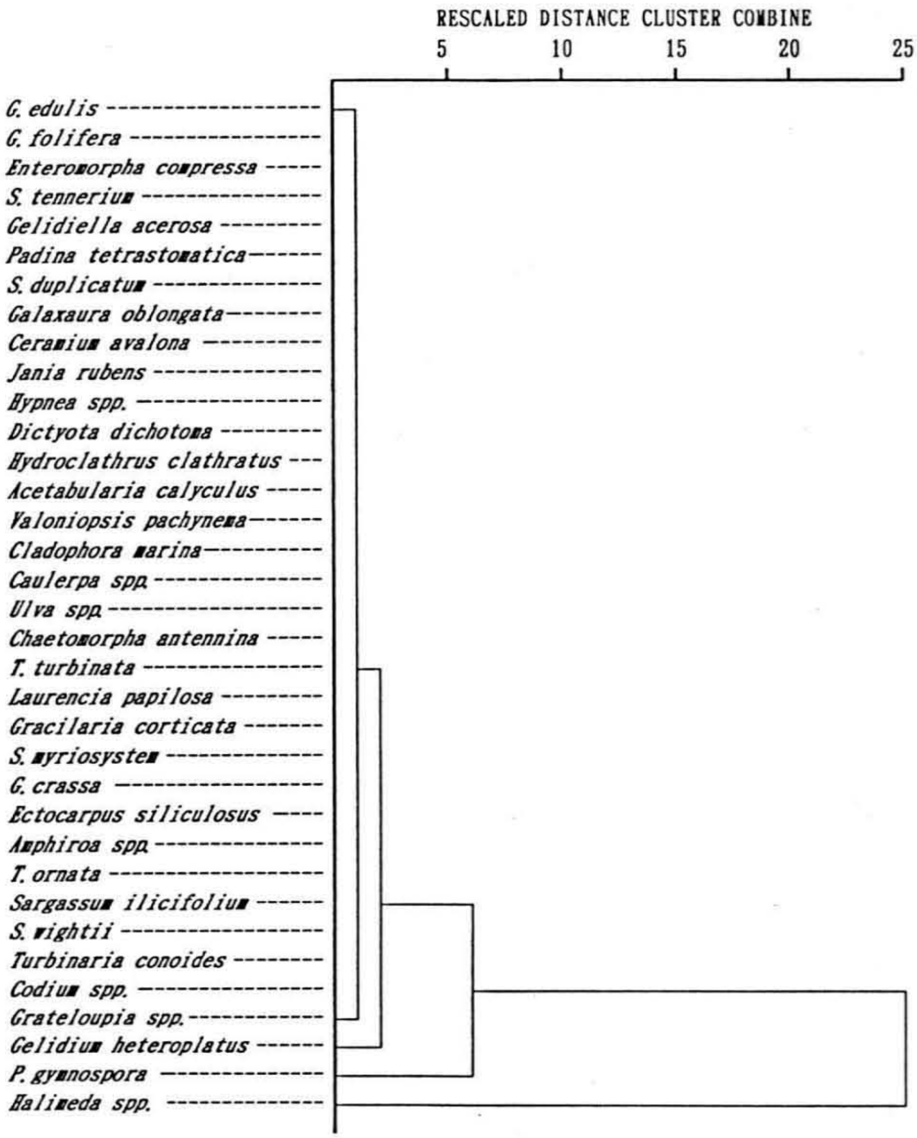


FIGURE - 20b

DENDROGRAM USING AVERAGE LINKAGE (BETWEEN GROUPS)

SUBTIDAL PART IN PREMONSOON SEASON

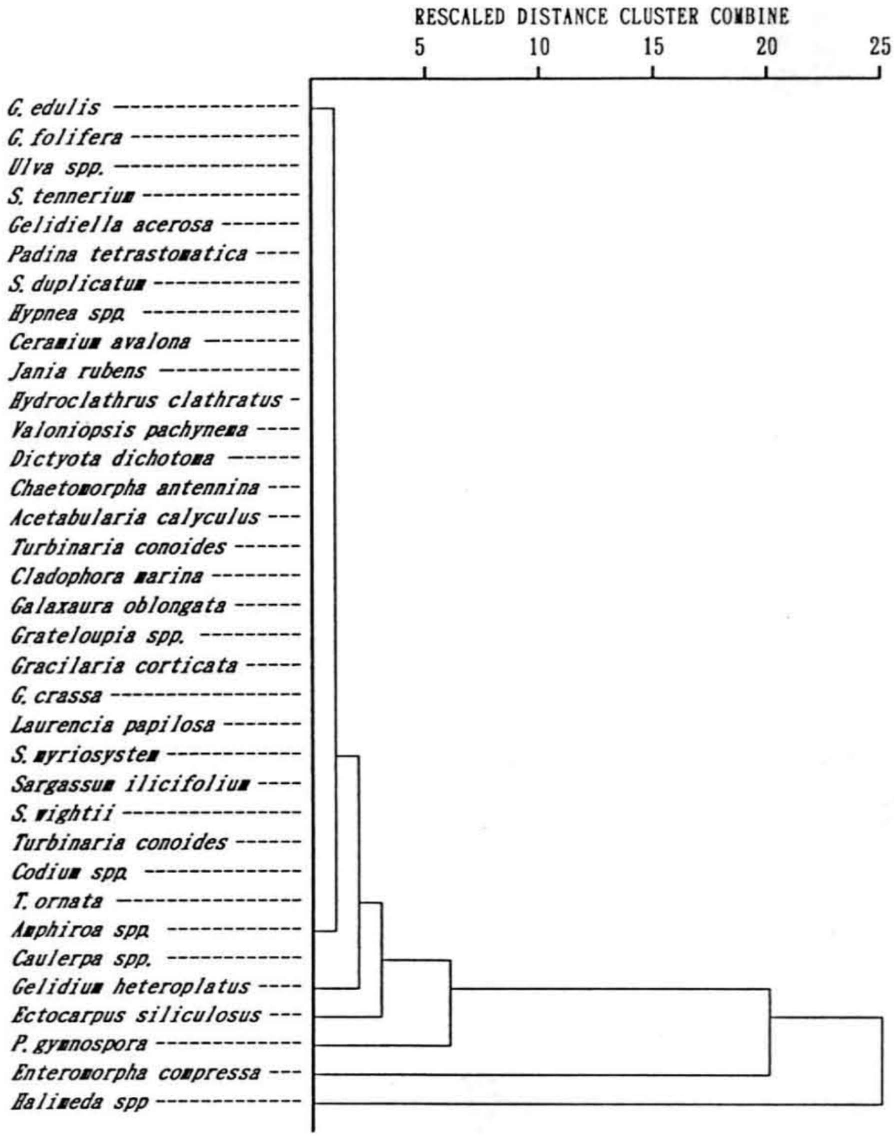


FIGURE - 20c

DENDROGRAM USING AVERAGE LINKAGE (BETWEEN GROUPS)

BOTH TIDAL PARTS TOGETHER IN PREMONSOON SEASON

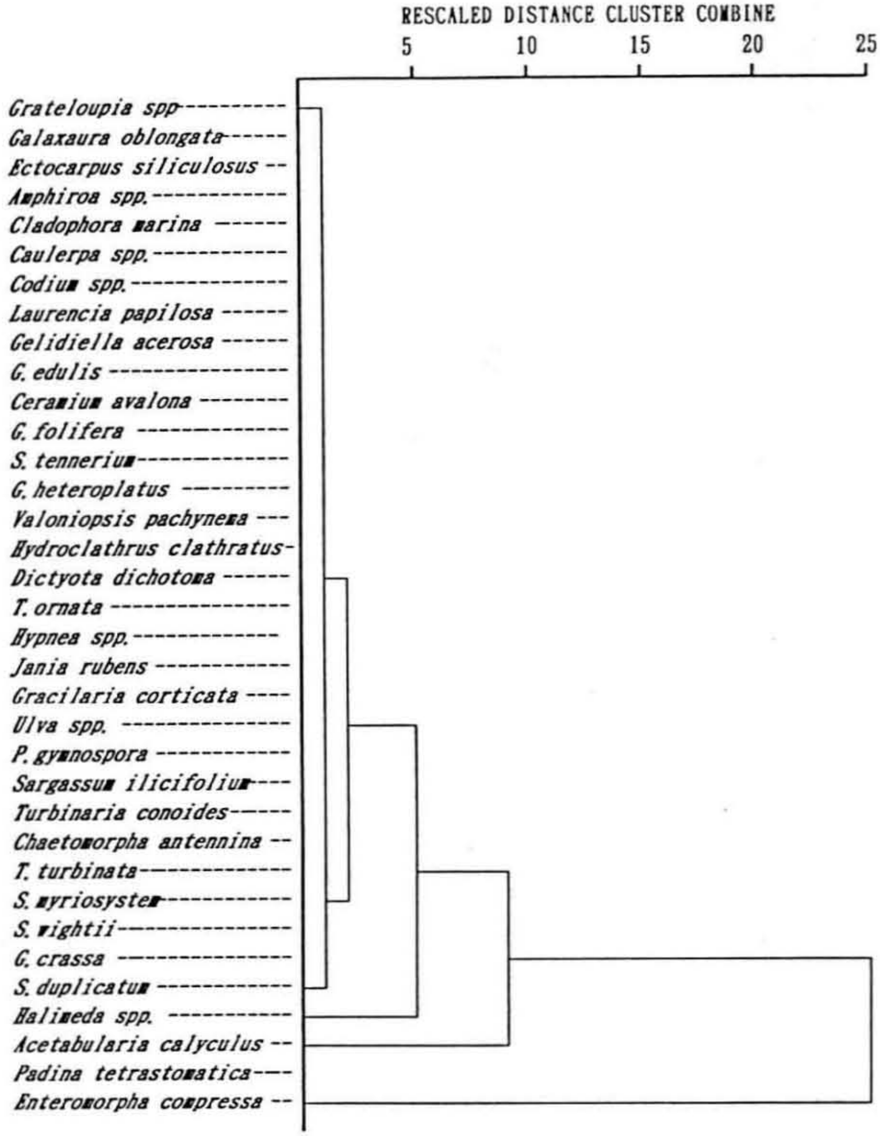


FIGURE - 21a
DENDROGRAM USING AVERAGE LINKAGE (BETWEEN GROUPS)
INTERTIDAL PART IN MONSOON SEASON

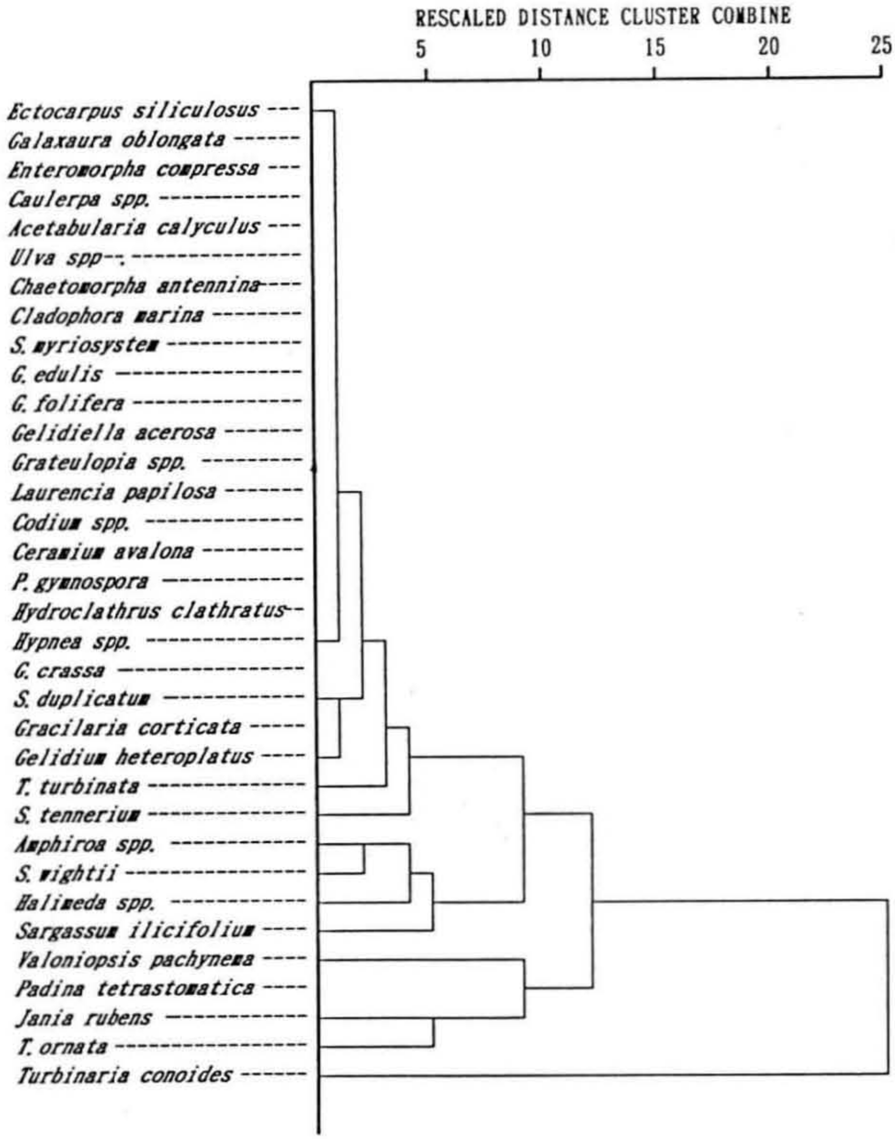


FIGURE - 21b

DENDROGRAM USING AVERAGE LINKAGE (BETWEEN GROUPS)

SUBTIDAL PART IN MONSOON SEASON

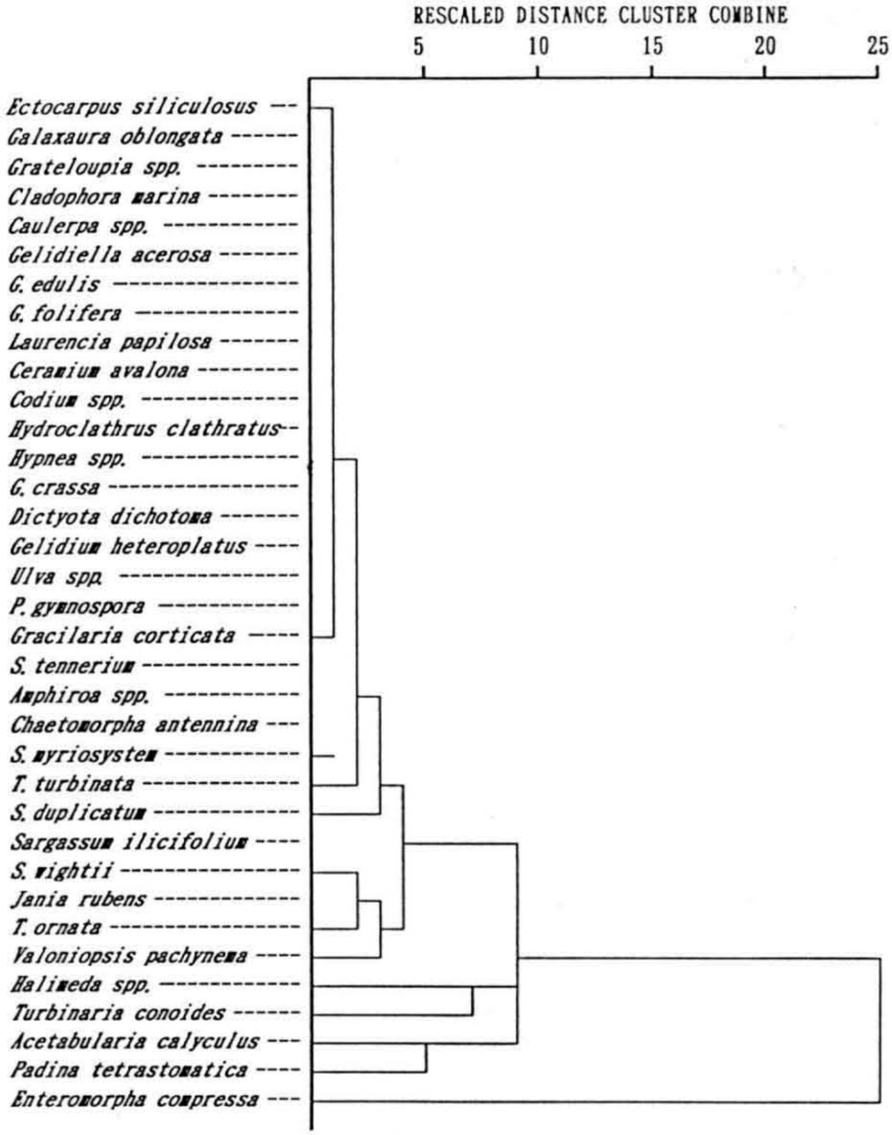


FIGURE - 21c

DENDROGRAM USING AVERAGE LINKAGE (BETWEEN GROUPS)

BOTH TIDAL PARTS TOGETHER IN MONSOON SEASON

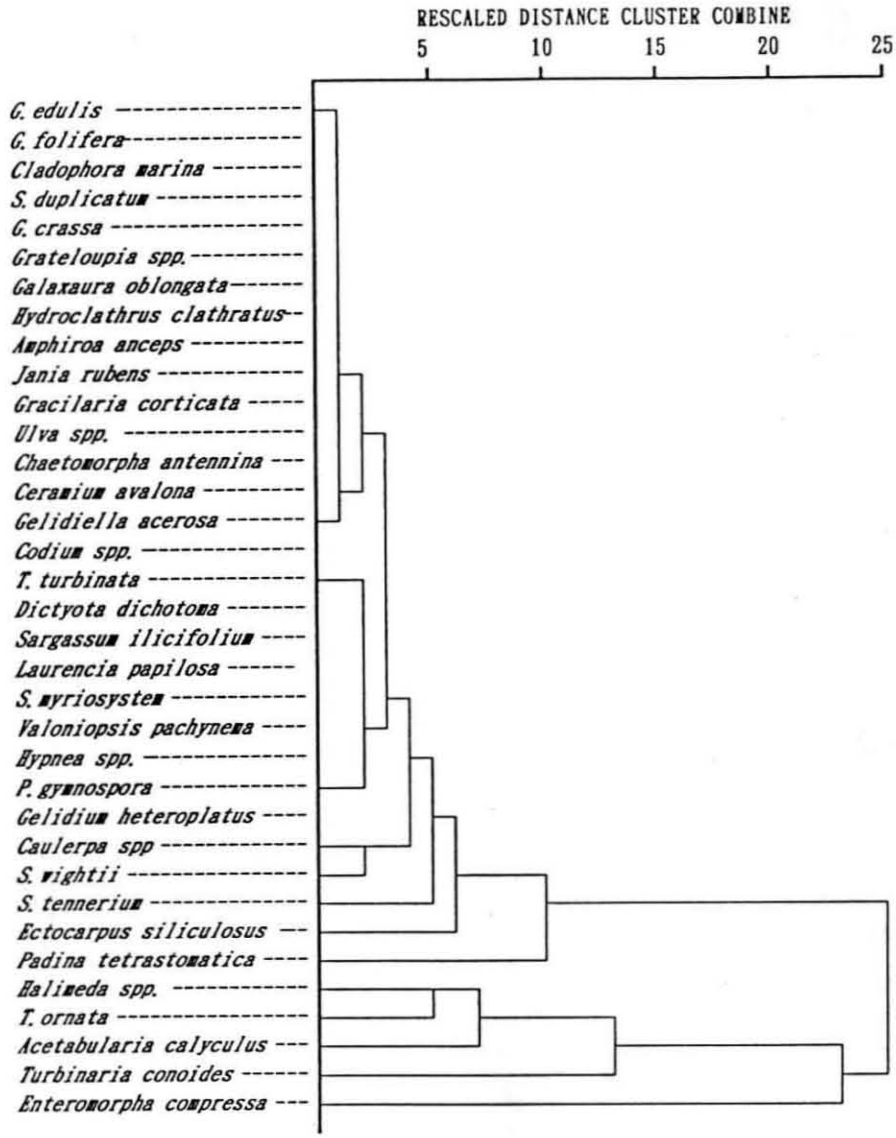


FIGURE - 22a

DENDROGRAM USING AVERAGE LINKAGE (BETWEEN GROUPS)

INTERTIDAL PART IN POSTMONSOON SEASON

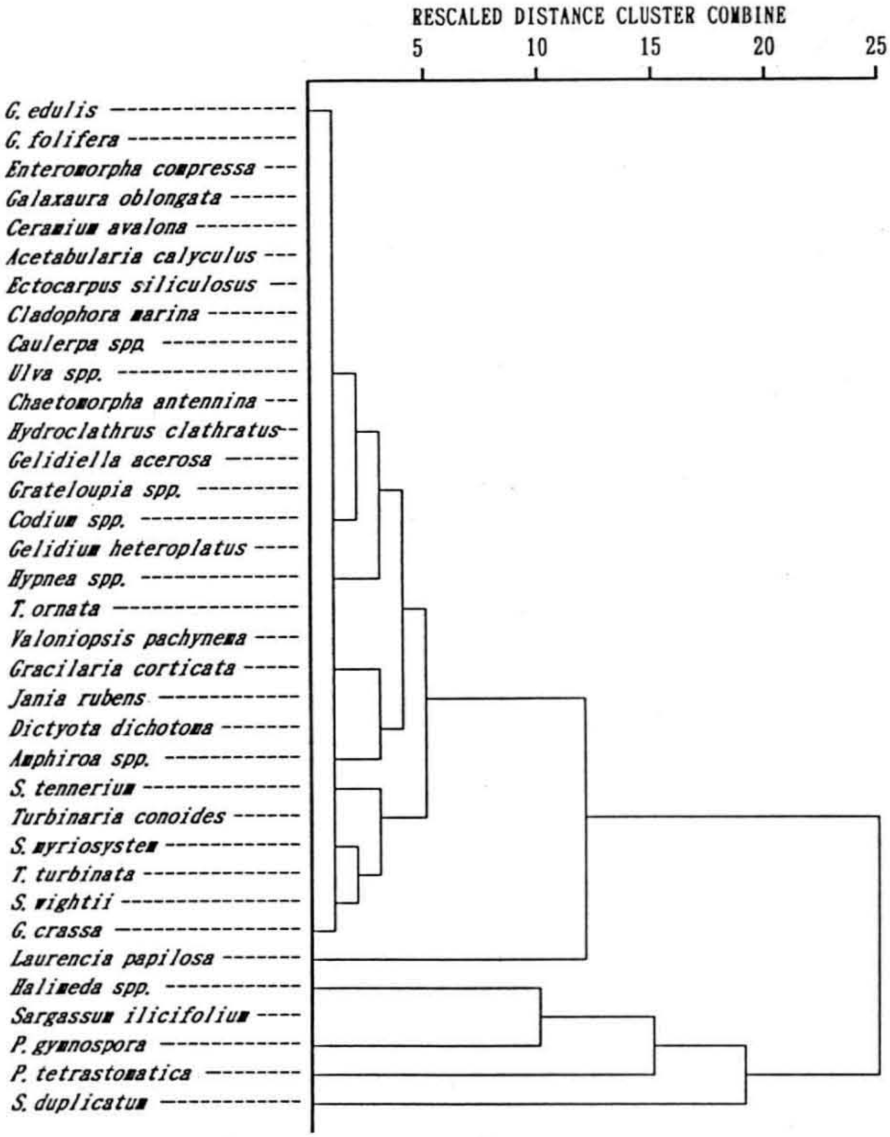


FIGURE - 22b

DENDROGRAM USING AVERAGE LINKAGE (BETWEEN GROUPS)

SUBTIDAL PART IN POSTMONSOON SEASON

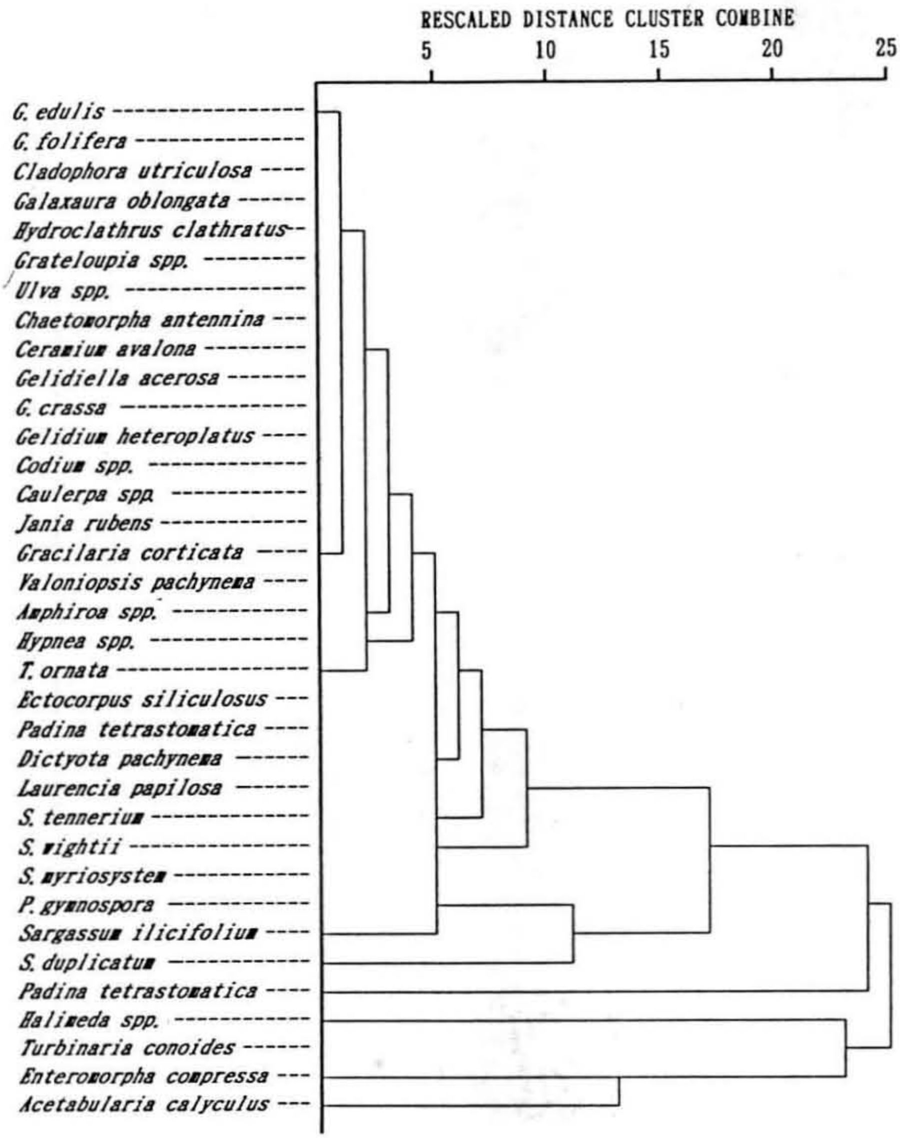


FIGURE - 22c
DENDROGRAM USING AVERAGE LINKAGE (BETWEEN GROUPS)
BOTH TIDAL PARTS TOGETHER IN POSTMONSOON SEASON

20b). However the dendrogram of both tidal parts together in postmonsoon express all species in one group with the Halimeda spp., Enteromorpha compressa and Padina gymnospora in domination (Fig. 20c).

During monsoon season, in contrast to premonsoon, the intertidal part has only one group with usual Enteromorpha compressa in the top (Fig. 21a). On the other hand, in the subtidal part there are four distinct groups in which Turbinaria conoides alone dominates among all the groups (Fig. 21b). Here, in the combined tidal parts dendrogram reveals that, there are three main groups with more than three species at the same time the species Enteromorpha compressa controls the overall domination as a single species in one group. (Fig.21c)

Finally in postmonsoon season, the intertidal part has four subgroups, where two are main subgroups having the rescaled distance of cluster combine more than ten. Among these groups, one is dominated by the species of Enteromorpha compressa, another group is by Turbinaria conoides and Padina tetrastomatica is followed after the above two groups. (Fig. 22a). But in the subtidal part, though there are four distinct groups, the group which has the species of Sargassum duplicatum, Padina tetrastomatica, Padina gymnospora, Sargassum ilicifolium and Halimeda spp.

have the overall domination against all other three groups. (Fig.22b)

The combined tidal parts show two distinct group dominations where the species of Acetabularia calyculus, Enteromorpha compressa, Turbinaria conoides and Halimeda spp. stand in one group and the rest form another group. (Fig.22c)

In general, the species Enteromorpha compressa dominates in intertidal part in all three seasons and the Halimeda spp. dominates in both tidal parts in all three seasons. But in subtidal part the species of alginophytes always have their prominant domination in certain level in all three seasons, more over it increases gradually from premonsoon to postmonsoon. On the basis of economical point of view it is clear that during monsoon and postmonsoon the species of alginophytes form seperate group and also dominate. Even though the species Enteromorpha compressa and Halimeda spp. which come from other algae group have the domination in all three seasons, the alginophytes cover major area with more number of species and support the idea that South Andaman is totally suitable for alginophytes culture.

4.4.2 Multiple regression analysis (Annexure II)

The results of multiple regression are presented to show significant relationship in the form of positive or negative correlation between the forcing factors and the seaweeds. Here the forcing factors (Environmental parameters) are considered as independent variables and the seaweeds which are affected (positively and negatively) by environmental factors are considered dependant variables. The multiple regression results contain F test and T test as main features. (Tables Ia - Va and Ib - Vb) The significant results are also presented in the table (27). Here, all 40 observations (fortnightly 20 months) have been included which contain groupwise biomass (agarophytes, alginophytes and other algae) and the environmental factors like tide, rain, relative humidity, wave, depth and light as common forcing factors and atmospheric temperature, water temperature, salinity, dissolved oxygen, phosphate, nitrate, nitrite and silicate as specific forcing factors.

In station I, the significant result of F.test supports other algae with 99.79% at Intertidal part, alginophyte with 95.97% at subtidal part, and totally for all species with 98.01%. In station II (the intertidal part) F. test does not support any group, at the same time at subtidal it supports with 98.04% which is significant for all groups (total). In station III for the subtidal and intertidal parts, F.test result is highly significant for all groups. In station IV intertidal part is highly

TABLE - 27

INTERRELTIONSHIP BETWEEN
SYSTEM AND FORCING (ENVIRONMENTAL) FACTORS

SYSTEM	PART	DEPENDENT VARIABLE (Seaweeds)	F - TEST (Leval of Significance) %	T - TEST (Level of significance) %													
				COMMON FORCING FACTORS						SPECIFIC FORCING FACTORS							
				Ti	R	RH	W	D	L	T1	T2	S	DO_2	PO_4	NO_3	NO_2	Si
1	Inter Tidal	Other Algae	99·79														
		Alginophytes	87·45		Ns95												
		Agarophytes	50·53														
		In Total	87.04														
	Sub Tidal	Other Algae	37·52														
		Alginophytes	95·97												Ns99		
		Agarophytes	54·27														
		In Total	98.01				Ns97								Ns96		
2	Inter Tida	Other algae	79·37														
		Alginophytes	86·17														
		Agarophytes	60·20														
		In Total	79.76											Ps94			
	Sub Tidal	Other algae	87·75									Ps98					
		Alginophytes	92·14									Ps98					
		Agarophytes	58·38									Ps95					
		In Total	98.04									Ps98					
3	Inter Tidal	Other algae	99·90		Ns99												
		Alginophytes	99·97		Ns99								Ps99				
		Agarophytes	99·25							Ns99							Ns97
		In Total	99.98		Ns99							Ps99	Ps99				
	Sub Tidal	Other algae	95·35												Ps95		
		Alginophytes	98·91														Ns97
		Agarophytes	99·99	Ps99					Ps96						Ps99		
		In Total	98.42														
4	Inter Tidal	Other algae	94·00		Ns97												
		Alginophytes	97·00	Ps99													
		Agarophytes	98·76	Ps98													
		In Total	98.07	Ps98													
	Sub Tidal	Other algae	99·93				Ns95					Ns97					
		Alginophytes	79·56														
		Agarophytes	70·63														
		In Total	78.19														
5	Inter Tidal	Other algae	99·99	Ps99			Ns99				Ns99	Ps99					
		Alginophytes	99·99	Ps99			Ns99					Ps99	Ps99				
		Agarophytes	99·90				Ns99										Ns99
		In Total	99.99	Ps99			Ns99						Ps99				
	Sub Tidal	Other algae	99·90									Ns98			Ps96		
		Alginophytes	99·97						Ps99						Ps98		
		Agarophytes	99·79						Ps95						Ps98		
		In Total	99.95						Ps99						Ps98		

Ti = Tide R = Rain RH = Relative Humidity W = Wave D = Depth L = Light

T1 = Atmospheric Temperature T2 = Water Temperature S = Salinity DO_2 = Dissolved Oxygen

PO_4 = Phosphate NO_3 = Nitrate NO_2 = Nitrite Si = Silicate

TABLE Ia

STATION 1 INTERTIDAL

SPSS/PC+

* * * * MULTIPLE REGRESSION * * * *

Equation Number 1 Dependent Variable.. DA

Multiple R	.77368
R Square	.59859
Adjusted R Square	.44089
Standard Error	35.50668

Analysis of Variance

	DF	Sum of Squares	Mean Square
Regression	11	52637.00828	4785.18439
Residual	28	35300.27747	1260.72420

F = 3.79578 Signif F = .0021

------------------ Variables in the Equation ------------------

Variable	B	SE B	Beta	T	Sig T
SI	3.37077	6.39189	.07143	.527	.6021
SALI	-2.47657	4.47407	-.11343	-.554	.5843
NO3	36.24030	38.12760	.14039	.951	.3500
RH	.48806	.57145	.11574	.855	.3995
TIDE	.05754	1.03203	7.3398E-03	.056	.9559
TEM1	1.38508	7.92072	.03701	.175	.8624
PO4	3.10509	3.76897	.12442	.824	.4169
DO2	1.62040	17.49364	.01470	.093	.9269
WAVE	18.05987	13.99328	.26954	1.291	.2074
RAIN	.65962	.34088	.39298	1.935	.0631
TEM2	-5.40683	11.14066	-.12902	-.493	.6262
(Constant)	337.26000	291.75713		1.156	.2575

* * * * MULTIPLE REGRESSION * * * *

Equation Number 2 Dependent Variable.. AL

Multiple R	.63270
R Square	.40030
Adjusted R Square	.16471
Standard Error	115.09485

Analysis of Variance

	DF	Sum of Squares	Mean Square
Regression	11	247586.41956	22507.85651
Residual	28	370911.10544	13246.82519

F = 1.69911 Signif F = .1255

------------------ Variables in the Equation ------------------

Variable	B	SE B	Beta	T	Sig T
SI	36.71045	20.71931	.29333	1.772	.0873
SALI	12.41898	14.50268	.21447	.856	.3991
NO3	71.27913	123.59056	.10412	.577	.5687
RH	-.31560	1.85234	-.02017	-.170	.8659
TIDE	5.42967	3.34532	.26188	1.623	.1158
TEM1	-13.23307	25.67500	-.13333	-.515	.6103
PO4	-.55517	12.21710	-8.3856E-03	-.045	.9641
DO2	-63.82187	56.70561	-.21839	-1.125	.2699
WAVE	43.15796	45.35919	.24200	.951	.3495
RAIN	2.27552	1.10497	.51119	2.059	.0489
TEM2	24.70928	36.11243	.21910	.684	.4995
(Constant)	-324.72173	945.73038		-.343	.7339

SPSS/PC+

* * * * MULTIPLE REGRESSION * * * *

Equation Number 3 Dependent Variable.. GB

Multiple R	.52517
R Square	.27582
Adjusted R Square	-.00867
Standard Error	25.54061

Analysis of Variance

	DF	Sum of Squares	Mean Square
Regression	11	6956.70405	632.43471
Residual	28	18265.05724	652.32761

F = .96951 Signif F = .4947

------------------ Variables in the Equation ------------------

Variable	B	SE B	Beta	T	Sig T
SI	5.73418	4.59781	.25689	1.247	.2227
SALI	-2.21470	3.21028	-.13741	-.669	.4929
NO3	-28.15245	27.42508	-.20361	-1.026	.3134
RH	-.27308	.41105	-.12756	-.713	.4819
TIDE	.07324	.74236	.21334	1.303	.2280
TEM1	-4.99950	5.67752	-.24711	-.877	.3877
PO4	-3.32574	2.71109	-.24079	-1.227	.2301
DO2	-9.35703	12.50350	-.13058	-.744	.1633
WAVE	6.20096	10.06562	.17304	.624	.5377
RAIN	-.41702	.24520	-.46372	-1.701	.1001
TEM2	9.15358	8.01768	.40192	1.142	.2630
(Constant)	70.98662	209.06627		.338	.7377

* * * * MULTIPLE REGRESSION * * * *

Equation Number 4 Dependent Variable.. TOT

Multiple R	.63087
R Square	.39799
Adjusted R Square	.16149
Standard Error	153.42153

Analysis of Variance

	DF	Sum of Squares	Mean Square
Regression	11	435710.84081	39610.08371
Residual	28	659068.65919	23538.16640

F = 1.68283 Signif F = .1296

------------------ Variables in the Equation ------------------

Variable	B	SE B	Beta	T	Sig T
SI	45.82638	27.61886	.27523	1.659	.1082
SALI	7.78034	19.33208	.10099	.402	.6904
NO3	79.12739	164.74632	.08687	.480	.6347
RH	-.11015	2.46917	-7.9288E-03	-.048	.9622
TIDE	6.36010	4.45931	.23130	1.431	.1636
TEM1	-16.89703	34.22480	-.12796	-.494	.6253
PO4	-.70342	16.78541	-8.0956E-03	-.040	.9670
DO2	-71.47014	75.50862	-.18307	-.946	.3524
WAVE	67.54762	60.46384	.20571	1.117	.2735
RAIN	2.52029	1.47293	.42555	1.711	.0981
TEM2	28.48157	48.13770	.11982	.592	.5589
(Constant)	79.77660	1260.65736		.063	.9500

TABLE Ib

STATION 1 SUBTIDAL

SPSS/PC+

* * * * MULTIPLE REGRESSION * * * *

Equation Number 1   Dependent Variable.. Y1

Multiple R	.49275
R Square	.24200
Adjusted R Square	-.05467
Standard Error	149.07059

Analysis of Variance

	DF	Sum of Squares	Mean Square
Regression	11	199520.41176	18138.21925
Residual	28	622217.12048	22222.04002

F = .81623   Signif F = .6248

------------------ Variables in the Equation ------------------

Variable	B	SE B	Beta	T	Sig T
X11	-52.90439	58.52014	-.37862	-.904	.3737
X1	26.05065	121.50715	.04271	.214	.8318
X2	22.12651	49.23301	.08313	.449	.6566
X9	-99.27925	161.74104	-.12009	-.614	.5443
X5	-70.67222	48.07605	-.36264	-1.470	.1527
X4	31.06270	38.83105	.17588	.800	.4307
X8	-15.13417	27.84043	-.13575	-.544	.5910
X3	-35.27374	56.68371	-.17222	-.622	.5388
X7	-4.17612	79.61117	-.01504	-.052	.9585
X10	539.26677	501.45596	.41275	1.075	.2914
X6	-17.08162	73.10639	-.30500	-.739	.4659
(Constant)	112.79438	1699.97378		.066	.9476

* * * * MULTIPLE REGRESSION * * * *

Equation Number 2   Dependent Variable.. Y2

Multiple R	.68555
R Square	.46997
Adjusted R Square	.26175
Standard Error	76.77830

Analysis of Variance

	DF	Sum of Squares	Mean Square
Regression	11	146356.54123	13305.14038
Residual	28	165057.38677	5894.90667

F = 2.25706   Signif F = .0403

------------------ Variables in the Equation ------------------

Variable	B	SE B	Beta	T	Sig T
X11	37.41205	30.14060	.43473	1.241	.2248
X1	50.75964	62.50184	.13517	.811	.4242
X2	-41.43107	15.35729	-.25206	-1.734	.1135
X9	-239.56487	83.30417	-.47073	-2.876	.0076
X5	7.30736	24.76141	.06091	.295	.7701
X4	-11.77949	20.01010	-.10834	-.589	.5600
X8	8.64116	11.33912	.12591	.603	.5516
X3	-55.89057	29.19475	-.44328	-1.914	.0658
X7	-2.27069	41.08346	-.01320	-.055	.9562
X10	-256.15641	258.27317	-.31848	-.992	.3298
X6	-16.34759	11.90087	-.47434	-1.374	.1804
(Constant)	1273.71717	875.56567		1.455	.1567

SPSS/PC+

* * * * MULTIPLE REGRESSION * * * *

Equation Number 3   Dependent Variable.. Y3

Multiple R	.53436
R Square	.28554
Adjusted R Square	.00485
Standard Error	14.80473

Analysis of Variance

	DF	Sum of Squares	Mean Square
Regression	11	2452.67577	222.97054
Residual	28	6137.01104	219.18004

F = 1.01729   Signif F = .4573

------------------ Variables in the Equation ------------------

Variable	B	SE B	Beta	T	Sig T
X11	-2.54734	5.81184	-.17031	-.438	.6645
X1	15.41222	12.06731	.24712	1.277	.2120
X2	-8.66952	4.88950	-.31059	-1.773	.0871
X9	-23.60076	16.06380	-.27722	-1.469	.1529
X5	.16545	4.77460	.02334	.077	.9231
X4	-2.51114	3.05844	-.13907	-.631	.5205
X8	-.26556	2.76493	-.02304	-.096	.9241
X3	-1.69640	5.62946	-.08101	-.301	.7654
X7	11.74513	7.90647	.41364	1.486	.1485
X10	-44.84727	49.00137	-.33574	-.901	.3755
X6	-1.67875	2.77178	-.10785	-.467	.6441
(Constant)	133.40748	160.83044		.790	.4361

* * * * MULTIPLE REGRESSION * * * *

Equation Number 4   Dependent Variable.. Y4

Multiple R	.71144
R Square	.50615
Adjusted R Square	.31214
Standard Error	112.44229

Analysis of Variance

	DF	Sum of Squares	Mean Square
Regression	11	362828.42406	32984.40471
Residual	28	354011.54574	12643.26950

F = 2.60885   Signif F = .0199

------------------ Variables in the Equation ------------------

Variable	B	SE B	Beta	T	Sig T
X11	63.05123	44.14110	.40317	1.428	.1642
X1	103.42177	91.65150	.10153	1.130	.2687
X2	-56.70250	37.13591	-.22842	-1.527	.1326
X9	-373.82332	121.99748	-.40414	-3.064	.0048
X5	3.40978	36.26323	.01875	.094	.7258
X4	-8.93265	29.30491	-.05415	-.305	.7628
X8	19.17709	20.99975	.10417	.913	.3685
X3	-98.86348	42.75387	-.51401	-2.312	.0303
X7	13.39450	60.04903	.05164	.223	.8251
X10	-403.48051	378.24760	-.33065	-1.067	.2952
X6	-21.07447	17.42096	.40277	-1.209	.2362
(Constant)	1406.59609	1202.27140		1.159	.2561

TABLE IIa
STATION 2 INTERTIDAL

SPSS/PC+

* * * * MULTIPLE REGRESSION * * *

Equation Number 1   Dependent Variable.. Y1

Multiple R .60236
R Square .36284
Adjusted R Square .11253
Standard Error 43.08099

Analysis of Variance

	DF	Sum of Squares	Mean Square
Regression	11	29593.63553	2690.33050
Residual	28	51967.20947	1855.97177

F = 1.44955   Signif F = .2063

------------------ Variables in the Equation ------------------

Variable	B	SE B	Beta	T	Sig T
X11	-13.36030	12.99104	-.23205	-1.028	.3125
X5	3.97281	6.70877	.11356	.592	.5585
X6	.35893	.24108	.24692	1.484	.1470
X1	17.38810	15.99080	.19104	1.087	.2864
X10	-57.91850	82.00751	-.14821	-.785	.4063
X3	.42920	.71666	.12013	.597	.5541
X9	12.96129	9.98512	.37795	1.298	.2049
X2	-.52494	.39196	-.32405	1.339	.1912
X4	29.19296	17.29185	.45312	1.688	.1025
X7	1.14718	5.83962	.05503	.196	.8457
X8	9.17228	28.91750	.10193	.317	.7535
(Constant)	-54.47053	358.31704		.152	.8803

* * * * MULTIPLE REGRESSION * * *

Equation Number 2   Dependent Variable.. Y2

Multiple R .62722
R Square .39341
Adjusted R Square .15511
Standard Error 113.36053

Analysis of Variance

	DF	Sum of Squares	Mean Square
Regression	11	233363.92236	21214.90203
Residual	28	357817.09208	12050.61046

F = 1.65089   Signif F = .1383

------------------ Variables in the Equation ------------------

Variable	B	SE B	Beta	T	Sig T
X11	29.24469	34.18377	.18900	.856	.3995
X5	-8.92090	17.65302	-.09455	-.505	.6173
X6	-.03148	.63648	-8.031E-03	-.049	.9607
X1	36.74084	42.07717	.14979	.873	.3899
X10	-267.37765	215.99976	-.25374	-1.238	.2260
X3	2.48273	1.88577	.25760	1.317	.1987
X9	42.03352	26.27419	.45449	1.600	.1209
X2	1.00194	1.03137	.22935	.971	.3396
X4	-40.47791	45.50863	-.23309	-.890	.3810
X7	-8.44969	15.36600	-.15037	-.550	.5868
X8	-93.46276	76.09186	-.38513	-1.228	.2296
(Constant)	903.31908	942.85230		.958	.3462

SPSS/PC+

* * * * MULTIPLE REGRESSION * * * *

Equation Number 3   Dependent Variable.. Y3

Multiple R .54900
R Square .30148
Adjusted R Square .02695
Standard Error 50.20834

Analysis of Variance

	DF	Sum of Squares	Mean Square
Regression	11	30443.11714	2767.55610
Residual	28	70562.07869	2520.07424

F = 1.09820   Signif F = .3980

------------------ Variables in the Equation ------------------

Variable	B	SE B	Beta	T	Sig T
X11	11.80015	15.13787	.18481	.780	.4422
X5	-2.54774	7.81743	-.06544	-.326	.7469
X6	-.13470	.28186	-.08327	-.478	.6364
X1	21.24174	18.63337	.20982	1.110	.2640
X10	-136.27499	95.65208	-.31340	-1.425	.1653
X3	.87195	.83509	.21932	1.044	.3054
X9	14.97093	11.63521	.39220	1.287	.2087
X2	-.36165	.45673	-.20061	-.792	.4351
X4	-10.07359	20.14941	-.14050	-.500	.6210
X7	-.20313	6.80465	-8.760E-03	-.030	.9764
X8	-48.83836	33.69636	-.48778	-1.449	.1583
(Constant)	289.41222	417.53074		.693	.4939

* * * * MULTIPLE REGRESSION * * * *

Equation Number 4   Dependent Variable.. Y4

Multiple R .60366
R Square .36440
Adjusted R Square .11470
Standard Error 156.15547

Analysis of Variance

	DF	Sum of Squares	Mean Square
Regression	11	391443.08201	35585.72746
Residual	28	682766.99799	24384.53564

F = 1.45936   Signif F = .2024

------------------ Variables in the Equation ------------------

Variable	B	SE B	Beta	T	Sig T
X11	43.29755	47.08855	.20793	.919	.3657
X5	-8.98341	24.31724	-.07075	-.369	.7146
X6	.15471	.87676	.02933	.176	.8617
X1	61.84875	57.96180	.18753	1.057	.2751
X10	-401.75820	297.54225	-.28531	-1.350	.1878
X3	3.52137	2.59760	.27139	1.356	.1861
X9	66.94346	36.19301	.53708	1.850	.0749
X2	.42233	1.42873	.07101	.297	.7681
X4	-29.50447	62.67769	-.12619	-.471	.6415
X7	-6.60141	21.16685	-.08730	-.312	.7571
X8	-147.88529	104.81744	-.45257	1.410	[illegible]
(Constant)	1213.44681	1298.79829		[illegible]	[illegible]

TABLE IIb

STATION 2 SUBTIDAL

SPSS/PC+

* * * * MULTIPLE REGRESSION * * * *

Equation Number 1 Dependent Variable.. Y1

Multiple R	.63248
R Square	.40003
Adjusted R Square	.16433
Standard Error	33.54872

Analysis of Variance

	DF	Sum of Squares	Mean Square
Regression	11	21012.66454	1910.24223
Residual	28	31514.46670	1125.51667

F = 1.69721 Signif F = .1259

------------------ Variables in the Equation ------------------

Variable	B	SE B	Beta	T	Sig T
X11	2.24256	7.13777	.00450	.314	.7557
X8	2.57597	4.10792	.10242	.627	.5357
X5	.37924	12.97009	6.6744E-03	.029	.9769
X10	-11.01536	78.93105	-.02783	-.140	.8900
X1	9.66601	15.03171	.13275	.643	.5254
X9	-67.98589	38.91171	-.51495	-1.747	.0916
X4	6.79286	7.94400	.19026	.855	.3998
X6	-11.86696	4.75641	-.65949	-2.495	.0188
X7	21.37802	16.94586	.32199	1.262	.2175
X2	3.14826	18.33018	.04682	.172	.8649
X3	-9.82327	16.78583	-.10978	-.585	.5631
(Constant)	201.79118	351.75600		.574	.5708

SPSS/PC+

* * * * MULTIPLE REGRESSION * * * *

Equation Number 2 Dependent Variable.. Y2

Multiple R	.65660
R Square	.43113
Adjusted R Square	.20764
Standard Error	72.14422

Analysis of Variance

	DF	Sum of Squares	Mean Square
Regression	11	110445.77651	10040.52514
Residual	28	145734.07660	5204.78895

F = 1.92909 Signif F = .0786

------------------ Variables in the Equation ------------------

Variable	B	SE B	Beta	T	Sig T
X11	2.57300	15.34928	.04392	.168	.8680
X8	6.74039	8.83381	.12135	.763	.4518
X5	-53.52544	27.89128	-.42656	-1.919	.0652
X10	86.63926	169.73582	.09913	.510	.6137
X1	48.10981	[illegible].37467	.24943	1.741	.2750
X9	-56.12597	83.67697	-.19250	-.671	.5079
X4	6.41638	17.08302	.08139	.376	.7100
X6	-24.29907	10.22834	-.61137	-2.375	.0246
X7	11.35376	36.44871	.07743	.312	.7577
X2	75.48725	39.41779	.50832	1.915	.0657
X3	-33.97625	36.09677	-.29710	-.941	.3546
(Constant)	484.52291	756.42715		.641	.5270

SPSS/PC+

* * * * MULTIPLE REGRESSION * * *

Equation Number 3 Dependent Variable.. Y3

Multiple R	.54446
R Square	.29644
Adjusted R Square	.02004
Standard Error	31.82660

Analysis of Variance

	DF	Sum of Squares	Mean Square
Regression	11	11950.13232	1086.37567
Residual	28	28362.11027	1012.93251

F = 1.07251 Signif F = .4162

Equation Number 3 Dependent Variable.. Y3

------------------ Variables in the Equation ------------------

Variable	B	SE B	Beta	T	Sig T
X11	3.99565	6.77132	.17106	.590	.5599
X8	-1.52353	3.89706	-.06914	-.391	.6988
X5	12.63572	12.30431	.25385	1.027	.3132
X10	-74.20878	71.87937	-.21403	-.771	.3202
X1	-12.68704	14.26011	.19807	-.890	.3017
X9	38.24193	36.91430	.37065	1.036	.3091
X4	6.49000	7.53622	.20753	.861	.3965
X6	-9.25762	4.51226	-.58727	-2.052	.0497
X7	-.57600	16.07600	-.01075	-.037	.9707
X2	-10.57639	17.38726	-.17953	-.608	.5479
X3	-19.22333	15.92418	-.47376	-1.207	.2375
(Constant)	157.63714	333.69967		.470	.6361

* * * * MULTIPLE REGRESSION * * *

Equation Number 4 Dependent Variable.. Y4

Multiple R	.71108
R Square	.50678
Adjusted R Square	.31301
Standard Error	99.94662

Analysis of Variance

	DF	Sum of Squares	Mean Square
Regression	11	287308.02142	26126.23649
Residual	28	279701.17058	9989.32701

F = 2.61542 Signif F = .0196

------------------ Variables in the Equation ------------------

Variable	B	SE B	Beta	T	Sig T
X11	10.91798	21.26447	.12521	.513	.6117
X8	4.19092	12.23812	.05081	.343	.7341
X5	-8.01333	30.63981	-.04292	-.287	[illegible]
X10	-76.32132	235.14734	-.05867	-.325	.7477
X1	53.14526	44.70171	[illegible]	1.187	[illegible]
X9	-86.41455	115.92377	-.19921	-.745	.4627
X4	20.96226	23.66635	[illegible]	.886	[illegible]
X6	-42.12595	11.17006	-.71757	-2.974	[illegible]
X7	69.08523	50.40123	.31667	1.340	[illegible]
X2	33.32497	54.60833	.15002	.610	.5466
X3	-76.75635	50.60748	-.45112	[illegible]	[illegible]
(Constant)	[illegible]	1047.93339		[illegible]	[illegible]

TABLE IIIa

STATION 3 INTERTIDAL

SPSS/PC+

* * * * M U L T I P L E   R E G R E S S I O N * * *

Equation Number 1   Dependent Variable..   Y1

Multiple R	.81603
R Square	.66591
Adjusted R Square	.53466
Standard Error	30.48038

Analysis of Variance

	DF	Sum of Squares	Mean Square
Regression	11	82640.32707	7512.75701
Residual	28	41460.72022	1480.74001

F = 5.07363   Signif F = .0002

------------------ Variables in the Equation ------------------

Variable	B	SE B	Beta	T	Sig T
X11	-9.32804	9.66724	-.14472	-.965	.3428
X6	-16.16316	18.32029	-.33324	-.882	.3852
X1	-14.49129	28.10392	-.08728	-.516	.6107
X4	14.16556	13.64470	.17232	1.038	.3081
X9	.91329	4.88503	.02909	.187	.8530
X3	.41913	1.47283	.04696	.285	.7781
X10	74.70458	61.90494	.21332	1.207	.2376
X2	1.24554	.39874	.62332	3.124	.0041
X7	-8.57970	4.49160	-.40960	-1.915	.0658
X8	-39.48165	22.72295	-.42445	-1.738	.0933
X5	10.48162	18.15450	.23576	.577	.5683
(Constant)	798.39937	308.90879		2.585	.0153

* * * * M U L T I P L E   R E G R E S S I O N * * *

Equation Number 2   Dependent Variable..   Y2

Multiple R	.76534
R Square	.58604
Adjusted R Square	.42342
Standard Error	74.14820

Analysis of Variance

	DF	Sum of Squares	Mean Square
Regression	11	217940.03296	19812.73027
Residual	28	153942.73795	5497.95493

F = 3.60365   Signif F = .0030

------------------ Variables in the Equation ------------------

Variable	B	SE B	Beta	T	Sig T
X11	-14.20887	18.62789	-.12806	-.767	.4495
X6	-39.12571	35.30153	-.46577	-1.108	.2771
X1	-7.73187	54.15369	-.02670	-.143	.8875
X4	9.02987	26.27209	.06346	.343	.7338
X9	10.67087	9.41301	.17634	1.134	.2666
X3	-1.41462	2.83001	-.09157	-.498	.6221
X10	131.92748	119.28518	.21762	1.106	.2781
X2	2.15025	.76834	.67394	2.809	.0090
X7	-23.67170	8.65491	-.65136	-2.735	.0107
X8	-143.73767	43.78506	-.89267	-3.283	.0028
X5	30.41036	34.98707	.49908	1.078	.2916
(Constant)	1758.91211	595.23909		2.955	.0063

SPSS/PC+

* * * * M U L T I P L E   R E G R E S S I O N * * *

Equation Number 3   Dependent Variable..   Y3

Multiple R	.65904
R Square	.43433
Adjusted R Square	.21210
Standard Error	31.38443

Analysis of Variance

	DF	Sum of Squares	Mean Square
Regression	11	21175.78260	1925.07115
Residual	28	27579.51615	984.98272

F = 1.95442   Signif F = .0747

------------------ Variables in the Equation ------------------

Variable	B	SE B	Beta	T	Sig T
X11	-18.04633	7.88456	-.44669	-2.287	.0298
X6	-14.56941	14.91195	-.47923	-.975	.3379
X1	45.39986	22.92143	.43626	1.981	.0575
X4	-19.31101	11.12856	-.37479	-1.735	.0937
X9	-.95980	3.98421	-.04877	-.241	.8114
X3	.53942	1.20173	.09643	.419	.6560
X10	-59.52970	50.48940	-.27120	-1.179	.2483
X2	.03417	.32521	.02729	.105	.9171
X7	-11.97549	3.66333	-.91007	-3.269	.0029
X8	-25.27083	18.53274	-.43344	-1.364	.1836
X5	14.16599	14.80673	.50035	.957	.3469
(Constant)	574.26775	251.94466		2.279	.0305

* * * * M U L T I P L E   R E G R E S S I O N * * *

Equation Number 4   Dependent Variable..   Y4

Multiple R	.77212
R Square	.59617
Adjusted R Square	.43753
Standard Error	121.51102

Analysis of Variance

	DF	Sum of Squares	Mean Square
Regression	11	610327.52105	55484.50191
Residual	28	413417.97097	14764.92782

F = 3.75786   Signif F = .0022

------------------ Variables in the Equation ------------------

Variable	B	SE B	Beta	T	Sig T
X11	-41.69372	30.52662	-.22522	-1.366	.1827
X6	-67.81019	57.05070	-.50117	-1.207	.2376
X1	23.02059	88.74484	.04828	.259	.7977
X4	3.85108	43.00640	.01631	.089	.9294
X9	10.61357	15.42566	.11770	.688	.4971
X3	-.46123	4.63081	-.01779	-.099	.9217
X10	147.50053	195.47965	.14664	.755	.4568
X2	3.43627	1.25912	.59873	2.729	.0109
X7	-44.21051	14.18332	-.73333	-3.118	.0042
X8	-208.30280	71.75316	-.77967	-2.903	.0071
X5	62.97440	57.32718	.49316	1.099	.2813
(Constant)	3131.62562	975.45339		3.210	.0033

TABLE IIIb

STATION 3 SUBTIDAL

SPSS/PC+

* * * * MULTIPLE REGRESSION * * * *

Equation Number 1   Dependent Variable..   Y1

Multiple R	.67994
R Square	.46231
Adjusted R Square	.25108
Standard Error	35.05199

Analysis of Variance

	DF	Sum of Squares	Mean Square
Regression	11	29577.47286	2689.04299
Residual	28	34401.97814	1228.64208

F = 2.18863   Signif F = .0463

------------------ Variables in the Equation ------------------

Variable	B	SE B	Beta	T	Sig T
X11	-4.75373	10.84991	-.10152	-.438	.6646
X5	14.79710	12.39229	.21898	1.194	.2425
X2	28.27477	16.80337	.28403	1.683	.1036
X4	4.83709	3.39590	.22199	1.423	.1658
X1	5.49472	17.78151	.04612	.309	.7596
X9	65.51651	33.05013	.40514	1.982	.0574
X8	-6.85737	5.24719	-.25205	-1.307	.2019
X10	-20.05412	47.35978	-.08243	-.423	.6752
X6	-5.56171	4.31281	-.30789	-1.201	.2168
X3	11.28397	15.71803	.19739	.718	.4788
X7	9.04142	16.37954	.15220	.552	.5853
(Constant)	-69.78228	263.92975		-.264	.7934

* * * * MULTIPLE REGRESSION * * * *

Equation Number 2   Dependent Variable..   Y2

Multiple R	.64041
R Square	.41013
Adjusted R Square	.17839
Standard Error	51.76113

Analysis of Variance

	DF	Sum of Squares	Mean Square
Regression	11	52158.40736	4741.67340
Residual	28	75018.01739	2679.21491

F = 1.76980   Signif F = .1087

------------------ Variables in the Equation ------------------

Variable	B	SE B	Beta	T	Sig T
X11	-35.71271	16.02201	-.54075	-2.229	.0340
X5	-.79207	18.29964	-8.314E-03	-.043	.9650
X2	46.69981	24.8134	.33378	1.882	.0703
X4	3.11456	5.01470	.10149	.621	.5396
X1	31.21400	26.25789	.18584	1.189	.2445
X9	90.72630	48.81680	.39793	1.859	.0736
X8	-12.66549	7.74851	-.33936	-1.635	.1133
X10	-58.65393	69.93399	-.17603	-.867	.3932
X6	-9.14713	6.41301	-.35916	-1.426	.1648
X3	15.54506	23.21075	.19289	.670	.5085
X7	-1.48707	24.18761	-.01776	-.061	.9514
(Constant)	220.95512	387.74400		.567	.5753

SPSS/PC+

* * * * MULTIPLE REGRESSION * * * *

Equation Number 3   Dependent Variable..   Y3

Multiple R	.85727
R Square	.73490
Adjusted R Square	.63076
Standard Error	13.39741

Analysis of Variance

	DF	Sum of Squares	Mean Square
Regression	11	13932.43961	1266.58542
Residual	28	5025.73514	179.49054

F = 7.05656   Signif F = .0000

------------------ Variables in the Equation ------------------

Variable	B	SE B	Beta	T	Sig T
X11	-4.06437	4.14700	-.15245	-.980	.3354
X5	10.14486	4.73652	.27581	2.142	.0419
X2	6.06447	6.42251	.11224	.944	.3531
X4	2.36726	1.29776	.17779	1.824	.0787
X1	46.40761	6.79637	.71558	6.828	.0000
X9	35.59535	12.63532	.40437	2.817	.0083
X8	1.63641	2.00556	.11357	.816	.4214
X10	3.04511	18.10163	.02299	.168	.8676
X6	-.84970	1.65989	-.08642	-.512	.6127
X3	-6.56627	6.00767	-.21102	-1.093	.2837
X7	-5.67473	6.26051	-.17550	-.906	.3724
(Constant)	-95.69564	100.87800		-.949	.3509

* * * * MULTIPLE REGRESSION * * * *

Equation Number 4   Dependent Variable..   Y4

Multiple R	.61933
R Square	.38357
Adjusted R Square	.14140
Standard Error	94.79721

Analysis of Variance

	DF	Sum of Squares	Mean Square
Regression	11	156567.60693	14233.42600
Residual	28	251622.31307	8986.51118

F = 1.58387   Signif F = .1581

------------------ Variables in the Equation ------------------

Variable	B	SE B	Beta	T	Sig T
X11	-42.57097	29.34329	-.35973	-1.451	.1579
X5	24.19361	33.51462	.14175	.722	.4764
X2	85.09256	45.44429	.34359	1.870	.0671
X4	10.80545	9.18111	.19654	1.177	.2493
X1	60.60092	48.08764	.30158	1.260	.2180
X9	171.24022	89.40486	.41925	1.915	.0657
X8	-19.18873	14.19070	-.20407	-1.352	.1873
X10	-111.40720	128.88330	-.18129	-.870	.3910
X6	-14.73083	11.74501	-.32303	-1.254	.2199
X3	21.11689	42.50900	.14625	.497	.6232
X7	9.14881	44.29806	.05077	.207	.8379
(Constant)	-17.60792	713.77125		-.025	.9805

TABLE IVa
STATION 4 INTERTIDAL

SPSS/PC+

*** * * * MULTIPLE REGRESSION * * * ***

Equation Number 1   Dependent Variable..   Y1

Multiple R	.66670
R Square	.44447
Adjusted R Square	.22625
Standard Error	56.12191

Analysis of Variance

	DF	Sum of Squares	Mean Square
Regression	11	70564.72075	6414.97461
Residual	28	88190.71325	3149.66833

F = 2.03671   Signif F = .0631

------------------ Variables in the Equation ------------------

Variable	B	SE B	Beta	T	Sig T
X11	18.80782	21.40312	.29094	.879	.3870
X1	17.56384	22.85793	.12363	.760	.4487
X6	10.67062	10.31373	.21136	1.035	.3097
X2	1.07035	.46787	.47368	2.288	.0299
X5	-9.56782	11.33623	-.19027	-.844	.4058
X9	-1.59506	8.35822	-.04148	-.191	.8500
X8	8.50406	13.06869	.13513	.651	.5205
X7	11.09437	5.79573	.43328	1.914	.0659
X10	127.07934	116.01435	.24800	1.095	.2827
X3	-.26609	2.30373	-.02636	-.116	.9089
X4	-10.67213	23.12279	-.11855	-.462	.6480
(Constant)	-275.86005	482.20409		-.572	.5718

*** * * * MULTIPLE REGRESSION * * * ***

Equation Number 2   Dependent Variable..   Y2

Multiple R	.70015
R Square	.49021
Adjusted R Square	.28994
Standard Error	104.35762

Analysis of Variance

	DF	Sum of Squares	Mean Square
Regression	11	293222.95295	26656.63209
Residual	28	304934.37305	10890.51332

F = 2.44769   Signif F = .0274

------------------ Variables in the Equation ------------------

Variable	B	SE B	Beta	T	Sig T
X11	42.67190	39.79869	.34007	1.072	.2928
X1	111.09635	42.50309	.40207	2.614	.0142
X6	16.22430	19.17819	.16556	.846	.4047
X2	1.53464	.87000	.34982	1.764	.0886
X5	1.95159	21.07751	.01999	.093	.9269
X9	-15.03541	15.54195	-.20146	-.967	.3416
X8	16.56059	24.30099	.13557	.681	.5012
X7	9.21326	10.77705	.18537	.855	.3999
X10	323.08798	215.72649	.32483	1.498	.1454
X3	-.07351	4.28375	-3.752E-03	-.017	.9864
X4	-52.29236	42.99638	-.29925	-1.216	.2341
(Constant)	-878.41616	896.64938		-.980	.3356

SPSS/PC+

*** * * * MULTIPLE REGRESSION * * * ***

Equation Number 3   Dependent Variable..   Y3

Multiple R	.63327
R Square	.40103
Adjusted R Square	.16571
Standard Error	26.64514

Analysis of Variance

	DF	Sum of Squares	Mean Square
Regression	11	13307.36938	1209.94267
Residual	28	19878.97062	709.96524

F = 1.70423   Signif F = .1242

------------------ Variables in the Equation ------------------

Variable	B	SE B	Beta	T	Sig T
X11	11.93645	10.16161	.40381	1.175	.2500
X1	25.74770	10.85232	.39630	2.373	.0248
X6	-1.42347	4.89668	-.06167	-.291	.7734
X2	-.11342	.22213	-.10976	-.511	.6136
X5	-1.43653	5.38213	-.06248	-.267	.7915
X9	2.07244	3.96825	.11787	.522	.6056
X8	6.73937	6.20466	.23422	1.086	.2867
X7	4.41228	2.75165	.37688	1.604	.1200
X10	-25.31118	55.00042	-.10004	-.460	.6491
X3	-.61712	1.09375	-.13372	-.564	.5771
X4	-12.31523	10.97806	-.29920	-1.122	.2715
(Constant)	-27.57391	228.93722		-.120	.9050

*** * * * MULTIPLE REGRESSION * * * ***

Equation Number 4   Dependent Variable..   Y4

Multiple R	.71237
R Square	.50747
Adjusted R Square	.31398
Standard Error	155.00787

Analysis of Variance

	DF	Sum of Squares	Mean Square
Regression	11	693179.20843	63016.29168
Residual	28	672768.29157	24027.43898

F = 2.62268   Signif F = .0193

------------------ Variables in the Equation ------------------

Variable	B	SE B	Beta	T	Sig T
X11	73.45096	59.11510	.38736	1.243	.2244
X1	154.46239	63.13326	.37067	2.447	.0210
X6	25.56517	28.40630	.17264	.877	.3771
X2	2.49444	1.79225	.37627	1.930	.0638
X5	-9.00053	31.31650	-.06167	-.290	.7737
X9	-14.52396	23.08528	-.17878	-.629	.5344
X8	31.77654	35.09554	.17214	.880	.3862
X7	24.71098	16.00772	.32900	1.544	.1339
X10	424.46495	320.42991	.20211	1.325	.1960
X3	-.96564	6.36288	-.03261	-.152	.8805
X4	-75.38052	63.86479	-.28546	-1.180	.2478
(Constant)	-1182.56179	1331.84051		-.888	.3822

TABLE IVb

STATION 4 SUBTIDAL

SPSS/PC+

**** MULTIPLE REGRESSION ****

Equation Number 1   Dependent Variable..   Y1

Multiple R	.66012
R Square	.43576
Adjusted R Square	.21409
Standard Error	41.27834

Analysis of Variance

	DF	Sum of Squares	Mean Square
Regression	11	36845.61970	3349.60181
Residual	20	47709.22794	1703.90100

F = 1.96584   Signif F = .0730

------------------ Variables in the Equation ------------------

Variable	B	SE B	Beta	T	Sig T
X11	4.31366	7.05041	.16071	.611	.5460
X1	5.43036	16.14750	.05245	.337	.7388
X2	-19.82549	20.25435	-.17036	-.979	.3360
X7	1.63929	1.07898	.22166	1.519	.1377
X5	.39320	13.15490	4.7638E-03	.030	.9761
X4	-8.48006	6.36942	-.22566	-1.333	.1933
X3	-33.74031	16.76526	-.51367	-2.013	.0538
X9	54.81624	51.59043	.22887	1.063	.2971
X10	-57.70871	57.49641	-.20830	-1.004	.3241
X8	-4.38100	6.79015	-.15420	-.645	.5240
X6	-12.57713	5.57371	-.62900	-2.257	.0320
(Constant)	883.17801	342.37069		2.580	.0154

**** MULTIPLE REGRESSION ****

Equation Number 2   Dependent Variable..   Y2

Multiple R	.60298
R Square	.36359
Adjusted R Square	.11357
Standard Error	59.83417

Analysis of Variance

	DF	Sum of Squares	Mean Square
Regression	11	57270.69232	5206.42657
Residual	28	100243.58019	3580.12786

F = 1.45426   Signif F = .2044

------------------ Variables in the Equation ------------------

Variable	B	SE B	Beta	T	Sig T
X11	-10.67616	11.23137	-.29005	-1.039	.3079
X1	38.03002	23.40628	.26875	1.625	.1154
X2	30.84505	29.35928	.20332	1.051	.3024
X7	3.05874	1.56401	.30107	1.743	.0621
X5	6.71913	17.06841	.06480	.363	.7194
X4	-16.70306	9.23122	-.32533	-1.809	.0811
X3	-9.36495	24.30174	-.10444	-.305	.7029
X9	-3.57222	74.70185	-.01093	-.048	.9622
X10	53.17474	83.34275	.14063	.638	.5206
X8	10.10634	9.84253	.26062	1.027	.3133
X6	-9.01762	8.07926	-.33042	-1.116	.2730
(Constant)	722.97483	196.27645		1.457	.1563

SPSS/PC+

**** MULTIPLE REGRESSION ****

Equation Number 3   Dependent Variable..   Y3

Multiple R	.57676
R Square	.33208
Adjusted R Square	.06968
Standard Error	21.71980

Analysis of Variance

	DF	Sum of Squares	Mean Square
Regression	11	6566.74368	596.97670
Residual	28	13208.11100	471.71020

F = 1.26554   Signif F = .2937

------------------ Variables in the Equation ------------------

Variable	B	SE B	Beta	T	Sig T
X11	2.76168	3.71386	.21275	.744	.4633
X1	10.91346	8.49620	.21766	1.285	.2095
X2	-3.10121	10.65706	-.05769	-.291	.7732
X7	.11649	.56772	.03257	.205	.8389
X5	5.71559	6.92160	.14928	.826	.4159
X4	-4.94338	3.35082	-.27174	-1.475	.1513
X3	-14.36826	8.82124	-.45222	-1.629	.1146
X9	-14.58472	27.14490	-.12592	-.537	.5953
X10	3.21024	30.25241	.02402	.106	.9160
X8	-5.39306	3.57272	-.39257	-1.510	.1423
X6	-4.16082	2.93267	-.43027	-1.419	.1670
(Constant)	322.21095	180.14232		1.789	.0845

**** MULTIPLE REGRESSION ****

Equation Number 4   Dependent Variable..   Y4

Multiple R	.59855
R Square	.35827
Adjusted R Square	.10616
Standard Error	109.71459

Analysis of Variance

	DF	Sum of Squares	Mean Square
Regression	11	188164.17665	17105.83424
Residual	28	337044.12735	12037.29026

F = 1.42107   Signif F = .2181

------------------ Variables in the Equation ------------------

Variable	B	SE B	Beta	T	Sig T
X11	-1.51007	18.76070	-.02257	-.080	.9364
X1	56.76574	42.91880	.21968	1.323	.1967
X2	6.21255	53.03448	.02243	.115	.9090
X7	4.93036	2.86785	.26749	1.719	.0766
X5	15.64907	34.96469	.07927	.448	.6579
X4	-30.80549	16.92677	-.32850	-1.820	.0795
X3	-64.79123	44.56075	-.39567	-1.454	.1571
X9	54.55666	137.12332	.07137	.398	.6937
X10	5.14295	152.82076	7.4483E-03	.034	.9734
X8	.03019	18.04769	4.2631E-04	.002	.9987
X6	-24.70075	14.01448	-.49902	-1.760	.1055
(Constant)	1901.65540	907.95450		2.070	.0458

TABLE Va

STATION 5 INTERTIDAL

*** * * * M U L T I P L E   R E G R E S S I O N * * ***

Equation Number 1   Dependent Variable..   Y1

Multiple R	.79557
R Square	.63293
Adjusted R Square	.48873
Standard Error	32.91271

Analysis of Variance

	DF	Sum of Squares	Mean Square
Regression	11	52299.57043	4754.50822
Residual	28	30330.89432	1083.24623

F =   4.38913   Signif F = .0007

------------------ Variables in the Equation ------------------

Variable	B	SE B	Beta	T	Sig T
X11	7.88265	5.50412	.20832	1.432	.1632
X5	-2.76031	5.05063	-.08167	-.547	.5890
X1	38.29238	13.94837	.36802	2.745	.0104
X7	2.63441	1.20006	.30168	2.195	.0366
X6	-6.21840	2.91206	-.30305	-2.135	.0416
X10	48.07770	44.65577	.16221	1.077	.2908
X4	-39.08337	12.23712	-.61356	-3.194	.0035
X2	-.19224	.27971	-.17592	-.687	.4975
X9	1.19694	6.24833	.03607	.192	.8495
X3	-1.43509	1.34630	-.19707	-1.066	.2956
X8	37.60154	19.56451	.46563	1.922	.0648
(Constant)	230.60386	247.37159		.932	.3592

*** * * * M U L T I P L E   R E G R E S S I O N * * ***

Equation Number 2   Dependent Variable..   Y2

Multiple R	.73599
R Square	.54167
Adjusted R Square	.36162
Standard Error	89.00397

Analysis of Variance

	DF	Sum of Squares	Mean Square
Regression	11	262144.33724	23831.30339
Residual	28	221807.80376	7921.70728

F =   3.00835   Signif F = .0091

------------------ Variables in the Equation ------------------

Variable	B	SE B	Beta	T	Sig T
X11	-7.34418	14.88447	-.11180	-.493	.6256
X5	-16.34990	13.65812	-.19909	-1.197	.2413
X1	119.57506	37.71979	.47589	3.170	.0037
X7	6.09223	3.24526	.20828	1.877	.0709
X6	-6.48644	7.87491	-.13096	-.824	.4171
X10	-14.34456	120.76013	-.02000	-.119	.9063
X4	-116.05233	33.09217	-.75282	-3.507	.0015
X2	.60082	.75640	.16262	.794	.4337
X9	12.63272	16.89700	.15729	.748	.4609
X3	-4.59496	3.64073	-.26073	-1.262	.2173
X8	132.45984	52.90719	.67778	2.504	.0184
(Constant)	409.04645	668.95304		.611	.5458

*** * * * M U L T I P L E   R E G R E S S I O N * ***

Equation Number 3   Dependent Variable..   Y3

Multiple R	.64533
R Square	.41645
Adjusted R Square	.18720
Standard Error	35.98559

Analysis of Variance

	DF	Sum of Squares	Mean Square
Regression	11	25876.27430	2352.38857
Residual	28	36258.94845	1294.96244

F =   1.81657   Signif F = .0989

------------------ Variables in the Equation ------------------

Variable	B	SE B	Beta	T	Sig T
X11	-12.67964	6.01801	-.53482	-2.107	.0442
X5	-4.05176	5.52218	-.13825	-.734	.4692
X1	28.17711	15.25066	.31277	1.848	.0753
X7	.88596	1.31211	.11700	.675	.5051
X6	.03457	3.18394	1.9477E-03	.011	.9914
X10	-31.81663	48.82506	-.12379	-.652	.5199
X4	-38.26974	13.37964	-.69287	-2.860	.0079
X2	.46917	.30582	.35439	1.534	.1362
X9	8.39913	6.83170	.29187	1.229	.2291
X3	-.84895	1.47200	-.13444	-.577	.5687
X8	27.06808	21.39114	.38654	1.265	.2162
(Constant)	104.79258	270.46733		.387	.7014

*** * * * M U L T I P L E   R E G R E S S I O N * ***

Equation Number 4   Dependent Variable..   Y4

Multiple R	.73981
R Square	.54732
Adjusted R Square	.36948
Standard Error	138.77634

Analysis of Variance

	DF	Sum of Squares	Mean Square
Regression	11	651979.33546	59270.84868
Residual	28	539248.16454	19258.86302

F =   3.07759   Signif F = .0079

------------------ Variables in the Equation ------------------

Variable	B	SE B	Beta	T	Sig T
X11	-12.39139	23.20809	-.11937	-.534	.5976
X5	-23.39547	21.29595	-.18231	-1.099	.2813
X1	185.64262	58.81326	.47092	3.156	.0038
X7	9.60219	5.06006	.28961	1.898	.0681
X6	-12.78650	12.27867	-.16455	-1.041	.3066
X10	3.23613	188.27097	2.8756E-03	.017	.9864
X4	-193.38558	51.59779	-.79958	-3.748	.0008
X2	.86649	1.17937	.14948	.735	.4685
X9	22.24769	26.34604	.17657	.844	.4056
X3	-6.86069	5.67660	-.24013	-1.209	.2367
X8	197.73962	82.49367	.64492	2.397	.0234
(Constant)	751.64347	1043.04142		.721	[illegible]

TABLE Vb

STATION 5 SUBTIDAL

SPSS/PC+

****** MULTIPLE REGRESSION ******

Equation Number 1   Dependent Variable..   Y1

Multiple R	.64286
R Square	.41327
Adjusted R Square	.18276
Standard Error	30.01422

Analysis of Variance

	DF	Sum of Squares	Mean Square
Regression	11	17766.46638	1615.13331
Residual	28	25223.89978	900.85356

F = 1.79209   Signif F = .1037

------------------ Variables in the Equation ------------------

Variable	B	SE B	Beta	T	Sig T
X11	12.52406	6.49057	.36005	1.930	.0630
X6	-8.10602	3.46017	-.61690	-2.343	.0265
X10	9.45735	18.48203	.09151	.512	.6129
X2	-3.91327	29.23202	-.02292	-.134	.8945
X7	2.00200	8.77154	.03630	.228	.8210
X1	6.17069	13.92617	.08219	.443	.6611
X4	4.81597	7.65426	.11279	.629	.5343
X9	81.53349	38.66013	.38956	2.109	.0440
X5	14.13017	9.72570	.25352	1.454	.1571
X8	5.01626	4.33754	.23714	1.202	.2104
X3	-11.62258	11.82378	-.21657	-.983	.3340
(Constant)	170.52371	305.76827		.558	.5815

****** MULTIPLE REGRESSION ******

Equation Number 2   Dependent Variable..   Y2

Multiple R	.69364
R Square	.48113
Adjusted R Square	.27727
Standard Error	68.90669

Analysis of Variance

	DF	Sum of Squares	Mean Square
Regression	11	123566.38378	11233.30762
Residual	28	133256.58877	4757.16389

F = 2.36035   Signif F = .0327

------------------ Variables in the Equation ------------------

Variable	B	SE B	Beta	T	Sig T
X11	16.84875	14.91836	.19810	1.129	.2683
X6	-12.41418	7.95309	-.30659	-1.561	.1298
X10	-11.69281	42.48216	-.04629	-.275	.7852
X2	-74.65492	67.19067	-.17091	-1.111	.2760
X7	-6.77100	20.16109	-.05021	-.336	.7395
X1	22.01173	32.00804	.11995	.688	.4973
X4	-9.05719	17.59307	-.08694	-.515	.6107
X9	210.71431	88.85702	.41191	2.371	.0248
X5	62.96697	22.35419	.46196	2.817	.0088
X8	11.68078	10.42739	.17405	1.120	.2722
X3	-46.41675	27.17702	-.40289	-1.708	.0987
(Constant)	943.20438	702.79022		1.342	.1904

****** MULTIPLE REGRESSION ******

Equation Number 3   Dependent Variable..   Y3

Multiple R	.60124
R Square	.36148
Adjusted R Square	.11064
Standard Error	14.73957

Analysis of Variance

	DF	Sum of Squares	Mean Square
Regression	11	3443.85045	313.07731
Residual	28	6083.13533	217.25484

F = 1.44106   Signif F = .2078

------------------ Variables in the Equation ------------------

Variable	B	SE B	Beta	T	Sig T
X11	1.87630	3.18743	.11459	.589	.5608
X6	-.77775	1.67924	-.12607	-.459	.6499
X10	-6.34731	9.07666	-.13047	-.699	.4901
X2	-12.68718	14.35503	-.15706	-.884	.3843
X7	-.79197	4.30750	-.03047	-.184	.8555
X1	3.54806	6.83895	.10039	.519	.6080
X4	-3.93275	3.75890	-.19601	-1.046	.3044
X9	46.35044	18.98545	.47043	2.441	,0212
X5	9.42551	4.77615	.35904	1.973	.0584
X8	.62799	2.22832	.05439	.282	.7802
X3	-2.31261	5.00659	-.10422	-.390	.6994
(Constant)	173.47565	150.13855		1.155	.2577

****** MULTIPLE REGRESSION ******

Equation Number 4   Dependent Variable..   Y4

Multiple R	.67601
R Square	.45007
Adjusted R Square	.24516
Standard Error	103.07642

Analysis of Variance

	DF	Sum of Squares	Mean Square
Regression	11	251454.56550	22859.50595
Residual	28	297492.93450	10624.74766

F = 2.15153   Signif F = .0500

------------------ Variables in the Equation ------------------

Variable	B	SE B	Beta	T	Sig T
X11	31.21562	22.29025	.25114	1.400	.1724
X6	-21.27042	11.88310	-.45306	-1.790	.0843
X10	-8.54285	63.47469	-.02313	-.135	.8939
X2	-91.33596	100.39209	-.14972	-.910	.3707
X7	-5.53819	30.12368	-.02807	-.184	.8554
X1	31.69380	47.82599	.11816	.663	.5129
X4	-8.13772	26.28667	-.05343	-.310	.7592
X9	338.43747	132.76864	.45252	2.549	.0166
X5	86.53414	33.40050	.43424	2.591	.0150
X8	18.13845	15.58306	.20676	1.164	.2543
X3	-60.30108	40.60653	-.35801	-1.485	.1487
(Constant)	1205.51884	1050.08543		1.274	.2711

significant supported by the environmental factors for all groups except other algae whereas the subtidal part is highly singnificant only for other algae group. Station V shows that the environmental factor is highly significant for all groups like that of station III.

In general according to F.test the alginophytes and other algae have been supported by highly significant environment in six tidal parts but at the same time the agarophyte has got 5 tidal parts. So it can be concluded that the environmental factor is highly significant for all species in all stations except in station V.

From T - test the significance of independent variables (specific and common forcing factors) has been analysed individually in detail and the results are presented in table 27. The content of the result is as follows.

In station I, the intertidal part is negatively affected by rain only. The intertidal part of station I (College area) is situated near the civilized area. Due to rain, chances of seawage deposition near the shore is more and may reduce the seaweed growth considerably. In the subtidal part most of the rocks are exposed out of the sea from the subtidal part and may affect the bottom seaweeds by breaking the waves at the top which may influence erosion at the bottom. The Nitrate also has the positive significant value. The intertidal part of the station II which is situated near the Burmanala region is positively affected by the Phosphate and the subtidal part has the salinity in positive significance.

In station III (Cheriadapu), the intertidal part has been negatively affected by rain, atmospheric temperature, salinity, dissolved oxygen and silicate. Here the intertidal part is full of mangroves, due to over rain the nutrients accumulate only near the bottom of the mangroves, which may reduce the intertidal salinity considerably and silt deposition also will increase. Due to over temperature the mangroves undergo photorespiration cause (characteristic of C_3 plants) which ultimately release more Carbon dioxide and may cause the dissolved oxygen defficiency for the seaweeds. In subtidal part the light and nitrate has positive significant correlation and the silicate which affects the intertidal part also extents negative correlation upto subtidal part. The mangroves of the intertidal part extends its branches towards considerable subtidal area and affects the light penetration to subtidal region.

Station IV (Pongibalu) has long intertidal part, due to long period of exposure to the tide shows positive significance at the same time so many creeks and excessive rain gives negative significant correlation. In the subtidal part like station I the exposed rock from the subtidal part affects the seaweeds by breaking the waves, and the reason for influence on salinity may be due to creek and over rain.

Station V (Wandoor) has long intertidal part, due to long exposure period the tide has the positive correlation and since it is near open sea area heavy waves show negative significant values. Due to over exposure the temperature affects negatively and the scarcity of dissolved oxygen also affects positively. The creeks near the shore may be affected by reduced salinity and deposition of more silt (Si). At the same time in subtidal part because of over silt the turbidity may disturb the light penetration. Apart from this the salinity and nitrate also affects considerably.

To conclude this, in general the common forcing factors like tide, rain, light, wave and specific forcing factors like atmospheric temperature, salinity, dissolved oxygen, phophate, nitrate and silicate play major role by affecting positively (or negatively) the seaweed growth considerably has been proved by the T-test.

5. DISCUSSION

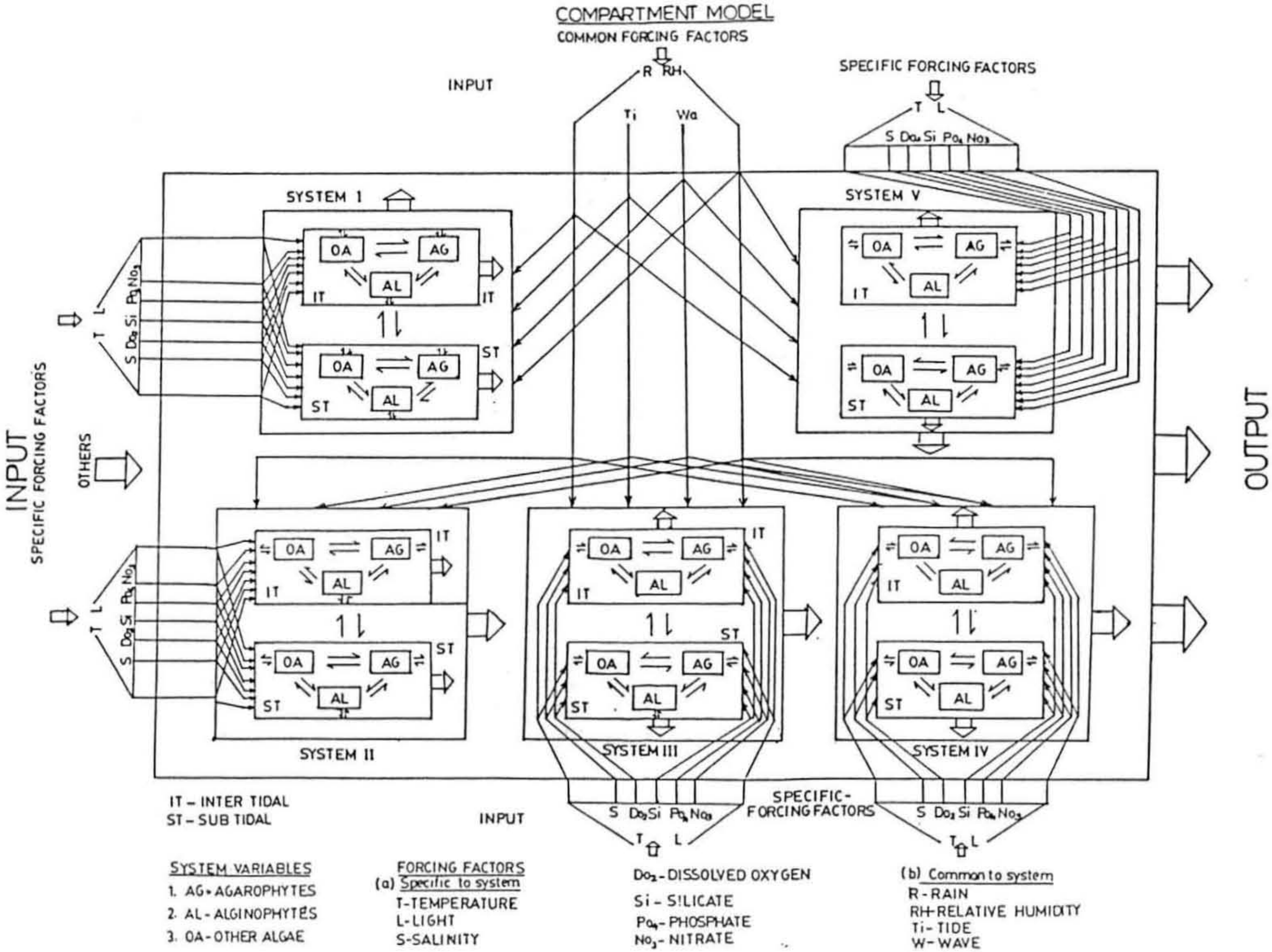
In the present study, the survey on seaweed resources were carried out in 9 islands of Andaman and Nicobar group of islands. In which, the Andaman group comprises South Andaman, Mayabunder (Middle Andaman), Diglipur (North Andaman), Neil and Havelock islands. The Nicobar group includes the following islands namely Car Nicobar, Terassa, Chowra and Bumpoka. So far, except Terassa, Chowra and Bumpoka islands, the rest of the island's seaweed resources have been studied qualitatively by Martens (1965), Hills (1959), Srinivasan (1965, 1969, 1973), Taylor (1966). But for the first time, the potential resources of seaweeds of above said islands are analysed quantitatively. Furthermore, in South Andaman the seaweed ecosystem is approached with a newly developed model (Fig. 23). The population and community level of interaction, and also the influence of environmental factors on seaweed ecosystem are analysed thoroughly.

5.1 SURVEY

From the overall survey results, it is observed that the alginophytes have the maximum standing crop biomass and it is predominantly higher in Andaman group (Table 11). It means the alginophytes standing crop biomass covers more

FIGURE - 23

The Assigned Compartment Model



than half of the total standing crop biomass of all seaweeds. The alginophytes covering 44590.22 $\pm$ 15757.20t and the total standing crop biomass of all seaweeds was 85124.57 $\pm$ 33401.06t in the survey area of 2227.02 hectare. On the other hand, the agarophytes are estimated only with 7055.32 $\pm$ 3563.37 t, comparatively 6 times lesser than the alginophytes quantity.

In all the islands, the alginophytes estimated were in good quantities, but the Andaman group has the maximum biomass than Nicobar group. Havelock island has the highest alginophytes biomass than the rest of the islands (15347.37 $\pm$ 4021.99 t). From the total alginophytes biomass (44590.22 $\pm$ 15757.20 t) almost one third comes from Havelock, in which the genus Turbinaria represent the maximum biomass followed by Sargassum. Apart from Havelock, South Andaman also has the second maximum biomass of alginophytes (10458.97 + 4191.90t). Though all the islands have comparatively good alginophytes vegetation, the Havelock and the South Andaman cover more than half of its total alginophytes biomass (25806.34 t out of 44590.22t). Jagtap (1983), in his littoral flora studies, observed good growth of alginophytes in Andaman islands, similar observation was also made by Gopinathan and Panigrahy (1983).

Considering agarophytes, though it has only 7055.32 $\pm$ 3563.37 t for the whole area of all surveyed islands, the South Andaman (2266.39 $\pm$ 778.67 t) and Car Nicobar (1635.01 $\pm$ 897.37 t) are the maximum contributers. From the table 11, it is clear that except Mayabunder and Diglipur (Middle and North Andaman) rest of the islands have the agarophytes biomass in considerable quantities.

In a total area of Andaman group (1567.16 ha.), the alginophytes biomass is 38112.86 and the agarophytes has 4069.97 t. On the other hand in Nicobar group, the alginophytes and agarophytes biomass are 6207.36 and 2985.35 t for the area of 659.86 hectare. That means, 24.32 t of alginophytes and 2.6 t of agarophytes are obtained per hectare from Andaman group, at the same time 9.407 and 4.527 t of alginophytes and agarophytes biomass per hectare are available from Nicobar group. From this view, the Andaman group supports for alginophytes vegetation and the Nicobar group supports for agarophytes.

Among other algae group the coral related genus Halimeda spp. has the highest biomass in the intertidal area in all the islands. Neverthless, the genus Enteromorpha also one of the good competitor against Halimeda spp. in the intertidal area.

In general, from this discussion it is true that the Andaman and Nicobar islands are good in alginophytes vegetation. Apart from these study area, even in main land, India, most of the survey reports have been published with alginophytes dominant vegetation. The seaweed resource study of Subbaramaiah et al. (1979) for the area of Athenkarai to Rameswaram in the Palk Bay; Sreenivasa Rao et al. (1964) and Chauhan and Mairh (1978) for Gujarat coast; Gulf of Kutch by Chauhan and Krishnamurthy (1968); the survey report of Bhanderi and Raval (1975) for Okha-Dwaraka coastal line; Maharastra coast by Chauhan (1978); Andrapradesh coastal line by Umamaheswara Rao (1978) and Idinthakarai to Pamban (TamilNadu) by Krishnamurthy et al. (1967) are the reports with good alginophytes vegetation in Indian coastal line.

In Mayabundar and Diglipur the overall seaweed vegetation is below the normal, at the same time the alginophytes exhibit comparatively better vegetation. Since these two areas have many culture cites, the possibility of further culture studies certainly lead to improve the seaweed vegetation, similar observation is also available from the report of Gopinathan and Panigraphy (1983).

In Neil Island, Gopinathan and Panigrahy (1983) reported that alginophytes were growing less in quantity, but during this study they are observed with a good quantity of (7298.91 $\pm$ 2364.99t) and also has comparatively been better than of Mayabundar and Diglipur regions. In Car

Nicobar also the same author observed poor seaweed vegetation, but in this study area 34 species are identified in which agarophytes and alginophytes are seven species each. Here, eventhough the standard deviation shows high fluctuation in biomass, it has been noticed that the most of the alginophytes and also agarophytes have good vegetation.

In general, totally all 9 islands give a good support for the alginophytes. The Andaman islands represent higher quantity of alginophytes than Nicobar group of islands, on the other hand the Nicobar group of islands show better vegetation for agarophytes.

The marine algal resource report of Lakshadweep islands (Subbaramaiah et al., 1979b) represents the agarophytes with better quantities than alginophytes. Since both the Nicobar and Lakshadweep group of islands are coral oriented, it may be possible to conclude that the coral oriented islands may support for agarophytes vegetation, than alginophytes. According to Chapman (1975), the Andaman islands may be attributed to volcanic soils. During this study alginophytes are predominant in all surveyed Andaman Islands, especially in Mayabunder (Middle Andaman) and Diglipur (North Andaman) though the agarophytes are less in vegetation, the alginophytes are observed with better biomass. Thus, it may be possible to conclude that the volcanic soils of Andaman is good for alginophytes.

In Andaman group the subtidal part has better vegetation than intertidal part, it may be due to mangrove vegetation. Jagtap (1983) reported that the mangrove vegetation was more dense towards Middle Andaman compared to the Little Andaman and South Andaman. Particularly about 1150km of Andaman and Nicobar group of islands are covered by mangroves (Blasco, 1977). On the other hand in Car Nicobar the intertidal part supports better vegetation than the subtidal part. Here, the intertidal area are mostly free of mangroves and also the shore has dead coral rocks in most of the area. The uneven depth and local currents supress the seaweeds in the subtidal part. Also the seasonal tidal behaviour and other changes in the physical condition of the marine environment brought about by monsoon that are responsible for the fluctuation in the growth and abundance of the intertidal algae (Umamaheswara Rao and Sreeramulu, 1964; Umamaheswara Rao, 1972; Ganesan _et_ _al_., 1991).

Apart from this, absence of suitable substratum which appears to be one of the important factor influencing the distribution and abundance of seaweeds (Burns and Mathieson, 1972). Also the influencing factors include temperature, salinity, light, nutrients availability, biological competition, grazing, pressure, wave exposure and substrata (Dring, 1982). In Andaman islands the coral related genus like Halimeda and Padina have better vegetation during all seasons, especially mangrove covered intertidal area. Similar observation was also made by King (1990) in Papua New Guinea.

Finally, during this study, the information of seaweed potential is estimated only for 9 islands and also discussed that the alginophytes have promisable biomass. However, intensive survey for a long period in other islands of Andaman and Nicobar group would give much light on the resources occurring in the natural habitat and on the raw material available for expanding the seaweed industry in our country.

5.2 THE MODEL

Since computer modelling has the profound effect on scientific research, many phenomenon are now investigated by complex computer models (Jerome Sacks et al., 1989). An attempt was made to form a rational model for the seaweed ecosystem of South Andaman. It has three main objectives, viz., first to consider the population response of individual seaweeds in different season, secondly the sociological relationship at community level and finally the effect of environment on seaweed ecosystem. Regarding this a compartment model has been developed (non-mathematical) for the above said study, the necessary quantitative analysis were carried out by related mathematical formula.

The model has five systems (stations), in each system it has two parts namely intertidal and subtidal. In each part the system variables (seaweeds) are observed in different seasons. Since the study is aimed for economical importance, the seaweed species are grouped into agarophytes, alginophytes and other algae. To know the availability of the species in different seasons, again they are further divided into two groups like seral and climax communities.

The compartment model, which has been developed for these studies exhibits the function in detail (Fig.23). It contains five systems with two parts namely subtidal and intertidal, the system variables have given in the form of other algae group (OA), alginophytes group (AL) and agarophytes (AG), the arrows show the possible interactions within the group and between the part. The input area which contains the forcing factors are two types, one is specific forcing factors for each individual system and second one is common forcing factors for all systems. In figure 24, one system has been represented with its forcing factors. The system variable study has been explained in figure 25. It

FIGURE - 24

A SYSTEM WITH POSSIBLE FORCING FACTORS

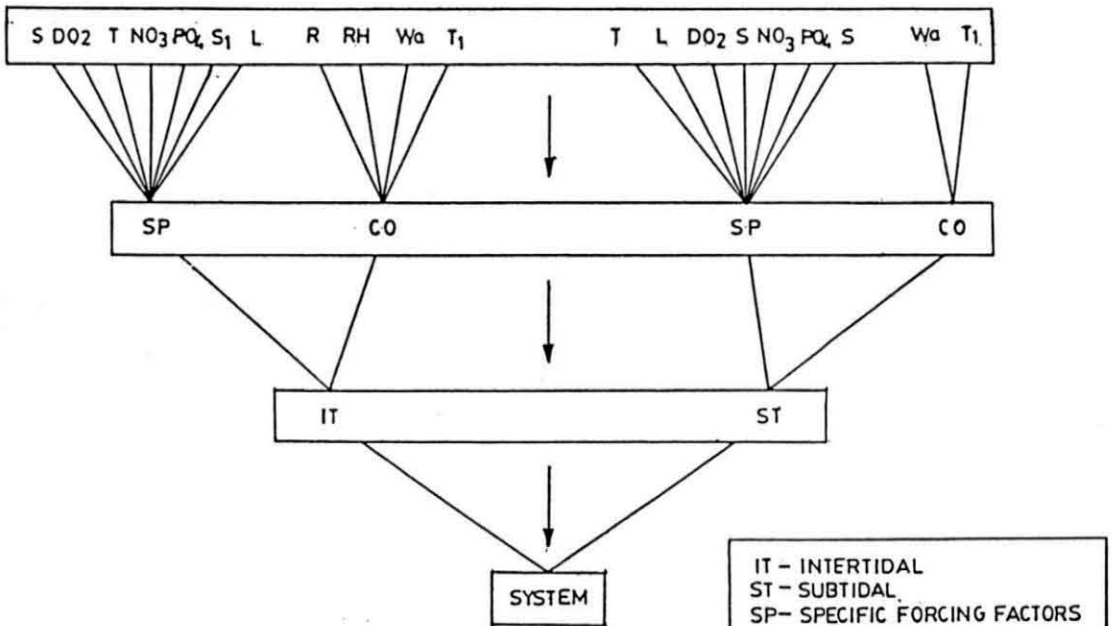
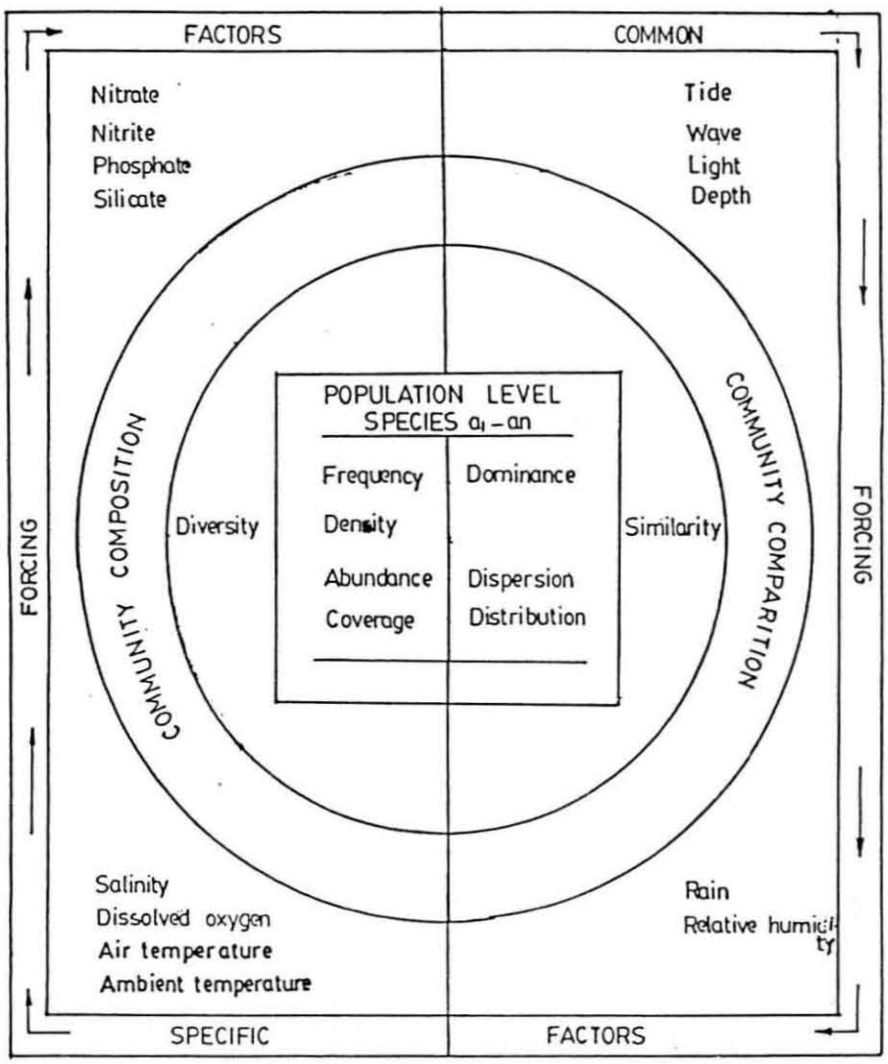


FIGURE - 25

THE SYSTEM AND APPROACH



starts with sampling method, population details, grouping, diversity approach for a part (subtidal or intertidal) and community relationship between the two parts of system in the form of similarity study.

The overall study approach with these main objectives has been represented in figure 26. Here, the first level of study starts from population level to know the details of frequency, density, abundance, coverage, dominance and patterns of distribution. The second level starts with community composition in the form of diversity for different seasons community comparison study with similarity analysis. It is used to understand the species that grow at a particular place to form a community in different seasons and their diversity and similarity pattern.

Several environmental factors that influence the distribution and abundance of the algal communities are examined in third level in the name of common forcing factor for all systems and specific forcing factor for each part of the system. In community composition study, the diversity pattern has been analysed in three ways. First it has been analysed a community as a whole, secondly the community has been subdivided into two groups on the basis of species availability like climax and seral sub communities.

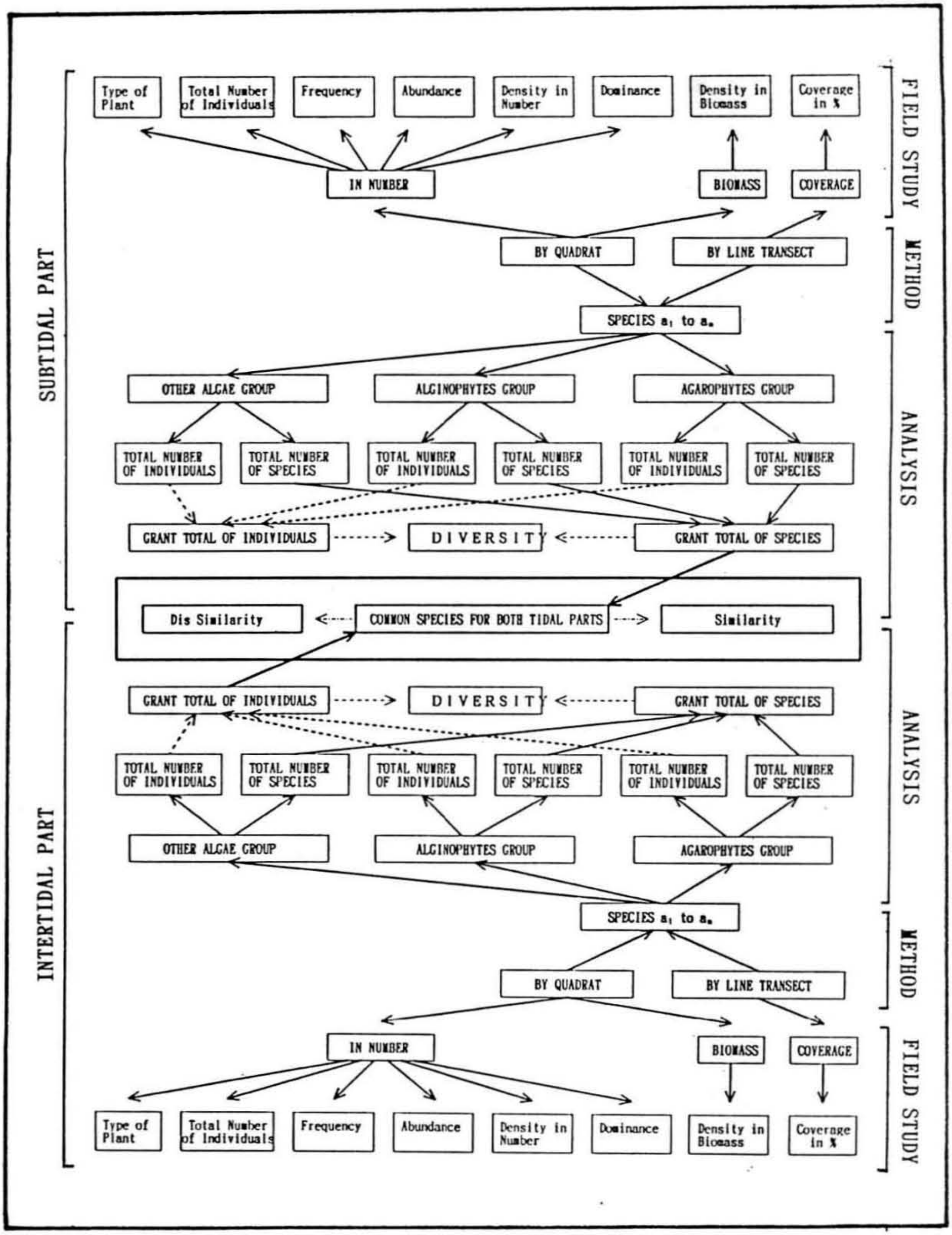


FIGURE - 26

The System Variable (Seaweed) Study Approach

The figure 27 expresses the 5 possible compositions (i) comparison within the system, (ii) comparison between the systems (iii) comparison between intertidal parts, (iv) comparison between subtidal parts and (v) comparison between intertidal and subtidal parts. Finally, figure 28 explains the possible comparison in different levels when the five parts are taken separately for the study.

5.2.1 POPULATION LEVEL

In South Andaman, totally 55 species were recorded during the period of investigation. For the sake of developing a suitable model, some of the less economically significant species were pooled and represented by 35 in number. Among these 8 species are included in climax sub community on the basis of availability in all the seasons and the rest are included in seral community.

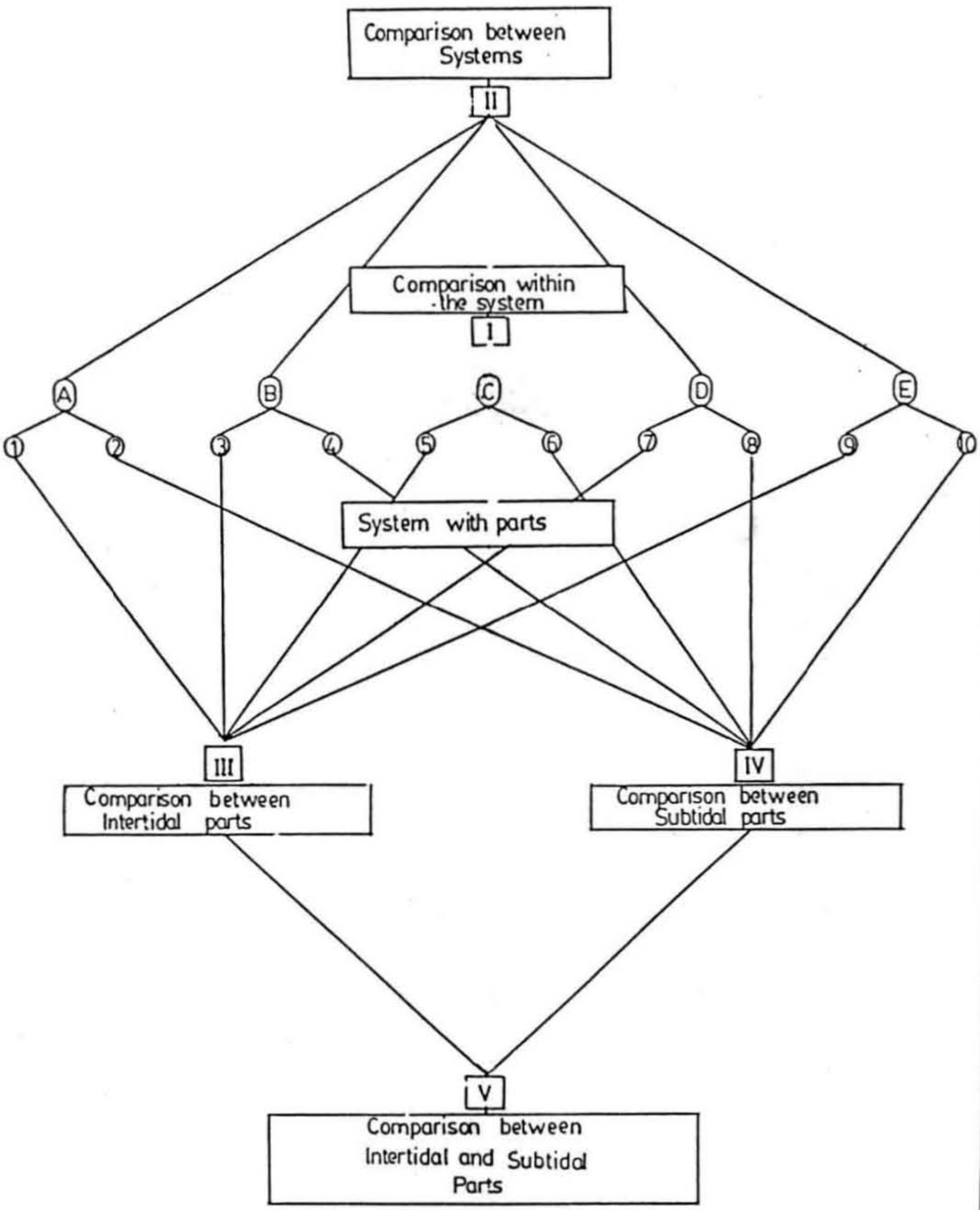
The monsoon and postmonsoon show high frequency distribution. Since the premonsoon period has the initial growing stage for most of the seaweeds, it should have got more % frequency, but the cluster form of distribution may be the reason for the low frquency during premonsoon.

The subtidal part shows more abundance than intertidal part. notably the station I has the lowest total

FIGURE - 27

COMMUNITY COMPARISON

(SIMILARITY STUDIES)



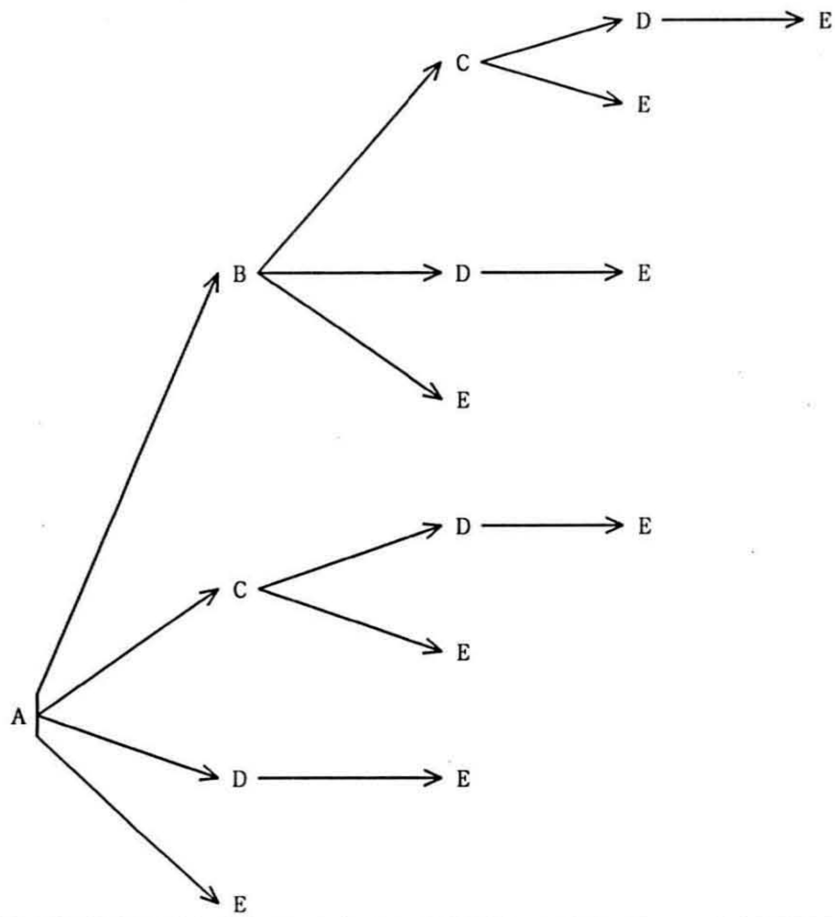
A, B, C, D & E = Systems (Stations) I, II, III, IV & V

1, 3, 5, 7 & 9 = Intertidal Parts

2, 4, 6, 8 & 10 = Subtidal Parts

FIGURE - 28

POSSIBLE COMPARISONS AT FIVE STAGES LEVEL



I LEVEL	II LEVEL	III LEVEL	IV LEVEL
AB AC AD AE BC BD BE CD CE DE	ABC ABD ABE ACD ACE ADE BCD BCE BDE CDE	ABCD ABCE ABDE BCDE ACDE	ABCDE

abundance. Density (numerical strength) has the maximum values during premonsoon and gradually reduces upto postmonsoon. On the otherhand the density (wet weight) is high during postmonsoon and gradually increases from premonsoon to postmonsoon. This inverse relationship may be concluded like, during earlier growth, the numerical density is higher for all species since they have numerous small number of individuals and when the species grow, the competition for necessory requirements leads to survive only the fittest species. At the same time growth which expresses the increment of weight and length of the organism automatically shows increased density (wet weight). When considering %cover, the lowest %cover is exhibited in the premonsoon season and the postmonsoon period shows the % cover nearly equal to that of the monsoon because of their matured stages in the growth of most of the species during this season. The dominance is always controlled by more than one species in all the seasons. The species of Sargassum, Turbinaria, and Halimeda define the dominant index in all the seasons for both tidal parts. The dominant index is low during premonsoon period and gradually increases upto postmonsoon period. Since the premonsoon allows earlier growth for most of the species, the dominant flow is shared by many number of species and when they attain maturity the number of dominant species are reduced. Finally the pattern of distribution of seaweed species in South Andaman is cluster (aggregated) in form and only during monsoon it slightly nears the random distributions. In general the alginophytes namely Sargassum spp., Turbinaria spp., and Padina spp., the other algae species like Halimeda spp. and Enteromorpha compressa have the strongest population control among all species. On the basis of availability throughout the season Sargassum spp. and Padina spp. (alginophytes) have the relative importance with Halimeda spp. (other algae)

5.2.2 COMMUNITY LEVEL

Individual organisms and the population formed by them live as an assemblage of species population in any given area forming a community. A community have certain features in common, they are (i) seral species occur in the same area (ii) it is possible to recognise a community type since the same group of species with more or less constant composition occur in space and time and (iii) communities tend to establish a dynamic stability (Michael, 1984). The results of important value index and phytosociograph express the social status of community structure that (i) in South Andaman the seaweed community structure is mainly affected by frequency (numerical strength) followed by cover and density. (ii) Almost the intertidal and subtidal parts have the same community structure except intertidal part of college area and Cheriadapu (because of civilization and mangroves respectively). Considering the community change by the sub community of seral and climax, out of 35 species, 8 numbers come under climax group and also has the strongest control all over the seasons. The rest of the species classified in the seral sub community, in which some of the species also control the dominant flow during certain stages of different seasons. In economically important seaweed subgroup, the alginophytes and the other algae group compete in all the seasons at the same time subcommunities like climax and alginophytes almost dominates in all stations. The diversity index values for the community as a whole and also for the sub communities have been moderate during premonsoon and nearly high during monsoon and postmonsoon. It may be confirmed that the monsoon and postmonsoon support more number of species and individuals too. The comparison between the systems expresses that the intertidal and subtidal parts of each system almost have same type of species during premonsoon. The ratio positively increases upto postmonsoon, but different stations has its own species specifically. The percentage of similarity is very high during the premonsoon season, gradually reduces and has very low values during postmonsoon. It is due to the increased level of uncommon species.

5.3 SEAWEEDS AND ENVIRONMENT

The results of seaweed ecosystem of South Andaman have been analysed at population and community level so far. It is expressed that the community as well as the individual population have seasonal changes and also differences in intertidal and subtidal levels. The seasonal development of organism may be controlled (i) directly by primary ecological factors such as favourable conditions of light intensity, temperature, and nutrients (2) by environmental signals photoperiod and narrow temperature interval or (3) by endogenous cicannual clock which becomes synchronizer (Zeitgeber), usually the annual course of photoperiod and in algae (1) and (2) have been confirmed and reported by Luning and Tom Dieck, (1989). Gruendling (1971)predicted gross primary production of epipelic algae in Marin lake, British Colombia, as a function of various ecological factors and concluded that light and temperature were most critical factors for the standing crop of dismids, diatoms and bluegreen algae, on similar line Hatcher et al. (1977) observed irradiance and temperature too contribute significantly to variance in net photosynthesis of Laurencia longicruris.

The most recent contribution to this line of study is by Mathieson and Penniman (1986). With respect to photography of marine flora form from the isles of shoals USA, all the above said evidences support the view that environmental factors cause the change in the population and community structure of seaweed ecosystem.

Considering the South Andaman the results of multiple regression analysis state that there are strong control of environmental factors on seaweed ecosystem (Table - 27). The possible factors analysed here are tide, rain, relative humidity, wave, depth, and light as a common forcing factors and atmospheric temperature, salinity, dissolved oxygen, phosphate, nitrate, nitrite and silicate as specific forcing factors for each system. The substratum and local environment have been analysed qualitatively. Among common forcing factors the tide, rain, wave and light influence the seaweed ecosystem. The tide is positively significant for all three groups (agarophytes, alginophytes, and other algae) in the area of intertidal part. The internal zonation is considered to be primarily under the influence of tidal levels and secondarily by other physical factors (Mathieson et al., 1977). Intertidal organism live in a tidal environment and there has been a search for an explanation in the rhythm of submergence and emergence, Doty (1946) supports of this observation.

The rain affects the intertidal parts with negative significance which means reduced rainfall may supports the seaweed growth. In South Andaman both the South West and North East monsoons influence a lengthy nine month period of rain fall. The continuous flow of rain water into the sea may affects the seaweed vegetation.

The wave also has negative significance in the intertidal seaweed community and also in the exposed plants in a number of ways. (1) by increasing drag on plants resulting plant removal, (2) by creating sediment which erodes or abrades plants (3) by impact, caving and shering.

Lewis (1964) has considered the importance of wave action in zonation of rocky shores. Southward and Orton, (1954) and Kingspuri (1962) have compared algal population of exposed and protected sides. The above reports have shown that an increase in species diversity in the area of moderate to high wave action.

The light has showed positive significance for the agarophytes in the subtidal parts. The reason is that agarophytes are receiving insufficient light in the subtidal parts, otherwise it would have shown significant distribution. Mathieson and Norall (1975); King and Schramm (1976a, 1976b); Arnold and Murray (1980); Dring (1981) are reported that the agarophytes in the subtidal part are much influenced by light.

Among specific forcing factors the atmospheric temperature, ambient temperature salinity, dissolved oxygen, phosphate, nitrate, nitrite and silicate play major role on the seaweed growth of this island.

The both atmospheric and ambient tempreature affect the intertidal part considerably with negative significant. Ambient air temperature, and relative humidity are the key factors contributing significantly in the mean monthly biomass (Murthy _et al_., 1989). An inverse relationship between mean monthly biomass and ambient air temperature was shown by Gaur _et al_. (1982) for _Ulva lactuca_ Lin. from Veraval coast of India. Murthy _et al_. (1978) reported the same for the intertidal algae at Port Okha on the Western coast of India.

The salinity plays positive role in subtidal area of certain stations (Station II, IV and V) and also in the intertidal of stations III and V. The salinity affects the agarophytes, alginophytes and other algae considerably. According to Munda (1978) the salinity can be an important factor in many cases of local distribution of marine algae. Kendric _et al_. (1990) in their recent publication described that the benthic algal species richness is lower in areas of high salinity. But in South Andaman the maximum salinity noted was nearly 35ppt. only in the area of station IV and V, where the results show with negative significance. On the other hand in station III, the salinity has very low value (24ppt) during monsoon and maximum value of 32 ppt., which also supported by Marichamy (1983), effects positively. The other related reports include Munns et al. (1983), Bolton (1979), Russel and Bolton (1975).

The dissolved oxygen effects positively in the intertidal part of station III and V. In station III, the mangroves are main factors which respire with pneumatophores and in station V the vast exposed intertidal part and competition of more number of species may be the reasons. Furthermore the dead mangroves may play the major role because Tokuyama and Arakaki (1988) reported that dissolved oxygen values may reach even zero in the dead mangroves area.

Studies assessing the relationship between nutrients and algal growth have focussed almost entirely on the phytoplankton (Tilman, 1982). This fact is unfortunate, in that benthic algae do play a significant role in the tropic water (Cattaneo and Kalff, 1980; Wetzel, 1983;

Strayer and Likens, 1986). Here the nutrients like nitrate and silicate influence the seaweed growth. Phosphate shows higher values in all seasons; Reddy et al. (1968) also observed phosphate with high quantities in Andaman Islands. Due to over siltation in the both tidal area of station I and II show positive significance. Considerable influence of nutrients in algal seasonality have been described by HO (1979), Luning and Tom Dieck (1989). Chapman and Craigie (1977) confirmed that nutrient concentration as a modifying factor for seaweeds. The other important relevent information were published by Eva Pip (1987), Walker and Coupland (1970), Seddon (1972), Reynolds and Reynolds (1975), Hinnery (1976), Helliquist (1980).

5.4 SEAWEED CULTURE POTENTIAL

During the study period, there were many possible culutre sites noticed, especially in the Andaman group of islands. The area which were enclosed by nearby islands were devoid of wave action. It may support for successful seaweed culture. In South Andaman the Wandoor area, the surrounding area near Mayabunder of Middle Andaman and the Shola Bay in Diglipur of North Andaman have vast culture sites.

The Neil and Havelock islands were also noticed with few culture sites. But in Nicobar groups (Car Nicobar, Terassa, Bumpoka and Chowra) the culture sites were not in suitable condition. It may be due to the open sea influence, heavy wave action and water currents near the shores.

From the survey, it was concluded that in most of the islands the subtidal area support good seaweed vegetation. So it is assumed that in all the above said islands, the subtidal area may support the healthy seaweed culture.

Since the alginophytes have dominant distribution in all Andaman islands, the possibility of alginophyte culture especially the species of Sargassum, Padina, and Turbinaria can be recommended. The important agarophyte species of Gracilaria and Gelidiella were also noticed in these islands. So by doing further experiments there may be a chance for agarophytes culture too.

6. SUMMARY

The present survey and ecological study were carried out for a period of 20 months from August 1988 to March 1990. During this period the data were collected from South Andaman, North Andaman, Middle Andaman, Havelock and Neil from Andaman group of islands and Car Nicobar, Terassa, Chowra and Bumpoka islands from Nicobar group of islands for the study.

6.1 SURVEY

The essential qualitative information and for the first time the quantitative analysis in the form of density and standing crop biomass of seaweeds were estimated for the above said islands.

The qualitative information is expressed with subtidal healthy vegetation and alginophytes domination. The mangroves dominated intertidal part of Andaman groups with muddy substratum supressed the intertidal vegetation considerably. On the other hand the vast exposed intertidal area with high wave action, local currents and open sea influence suppressed the seaweed vegetation in Nicobar group of islands.

The seaweeds are grouped as agarophytes which are yielding agar-agar, alginophytes which are yielding algin and the other algae. A total amount of density 3318.80 $\pm$ 1331.78 gm m^{-2} was derived for these nine islands, in which the agarophytes, alginophytes and other algae represented 260.51 $\pm$ 136.89 gm m^{-2}; 1655.46 $\pm$ 579.88 gm m^{-2} and 1426.61 $\pm$ 615.01 gm m^{-2} respectively. The estimated standing crop biomass for the total area of 2227.02 hectare was 85124.57 $\pm$ 15757.20 tonnes. The alginophytes exhibited with the high values of 44590.22 $\pm$ 15757.20 tonnes followed by the other algae group with 33479.03 $\pm$ 14080.49 tonnes.

In general, the alginophytes were dominated in all the islands both qualitatively and quantitatively. The agarophytes were recorded with better vegetation in Nicobar group of islands. It has been concluded that the volcanic oriented soil of Andaman group supports the alginophytic growth and the coral oriented Nicobar group supports the agarophytic growth.

6.2 THE MODEL

The South Andaman data were collected from five fixed stations fortnightly for the purpose of ecological modelling and system analysis studies. From this study, the population and community characters of seaweeds and the influence of environmental factors on seaweed ecosystem were analysed thoroughly.

The population parameters namely, frequency, density, abundance, cover, dominance, and patterns of distribution were estimated and discussed in detail. The community characters like community structure, composition and comparison were presented and discussed. The environmental factors were considered as forcing factors of the seaweed ecosystem. They were classified into two types namely common forcing factors for all five stations and specific forcing factors for each system. The tide, rain relative humidity, wave, depth and light were included as common forcing factors and the specific forcing factors were the atmospheric and ambient temperatures, salinity, dissolved oxygen, phosphate, nitrate, nitrite and silicate. The relative ecological position of the seaweed species with respect to environmental factors were estimated simultaneously by using agglomerative hierarchical cluster analysis. The results were presented in the form of dendrogram for both the tidal parts separately and also combined for three seasons.

At population level the frequency, abundance and coverage exhibited high values during monsoon and postmonsoon. The numerical and biomass(wet weight) density represented with inverse relationship which means the numerical density gradually reduced from premonsoon to postmonsoon. On the otherhand, the density in biomass was just opposite. In all the seasons the dominance were controlled by more than one species. Here also gradual increment of dominant values were recorded from premonsoon to postmonsoon. Almost in all seasons the patterns of distribution of South Andaman were aggregated and only in monsoon it was slightly nearing random distribution. The species of alginophytes namely Sargassum, Turbinaria, Padina and the other algal species like Halimeda and Exteromorpha compressa were recorded with the strongest population control among all other species.

At community level the community structure was mainly affected by frequency (numerical strength), followed by cover and density. Almost both the tidal parts exhibited same community structure except College area, (Station - I) and Cheriadapu (Station - III), because of civilization and mangroves respectively. The climax subcommunity showed overall dominance in all the seasons. The climax subcommunity showed overall dominance in all the seasons. The diversity index values for the community as a whole and also for the sub communities were responsed with moderate values during premonsoosn and were nearly high during monsoon and postmonsoon. The comparison study expressed that the intertidal and subtidal parts of each system were almost represented with the same type of species from monsoon to postmonsoon. But each station differed with specific species. The percentage of similarities were recorded with high values during premonsoon and low values in postmonsoon.

The dendrogram results expressed that the other algae Enteromorpha compressa dominated in the intertidal part in all seasons; Halimeda spp. dominated in both the tidal parts in all three seasons and Padina gymnospora dominated in subtidal part. But the alginophytes were represented in separate group with considerable dominance during monsoon and postmonsoon.

The multiple regression analysis with the help of F test and T test were used to study the influence of environmental factors on seaweed ecosystem. The result stated that there was a strongest control of environmental factors on seaweed ecosystem.

Among common forcing factors, the tide and light were exhibited with positive significance; the rain and wave were exhibited with negative significance. The depth variation and relative humidity did not show any significant values. The specific forcing factors like salinity and dissolved oxygen were observed with positive significance for the seaweed growth. The atmospheric and ambient temperatures showed negative significance. Among nutrients the nitrate (positively) and silicate (negatively) influenced the seaweed growth. The phosphate did not show any variation.

The possibilities of seaweed culture was supported with vast culture sites in Andaman group of islands since most of the islands were observed with healthy subtidal seaweed vegetation. It was assumed that the subtidal part may support for the possible seaweed culture. The species like Sargassum, Padina and Turbinaria, which were recorded with high density and standing crop biomass have been recommended for the possible seaweed culture.

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ANNEXURE I

LIST OF SEAWEEDS COLLECTED FROM THE STUDY AREA

Sl. No.	SEAWEEDS	SOUTH ANDAMAN 1	MAYABUNDER 2	DIGLIPUR 3	NEIL 4	HAVELOCK 5	CAR NICOBAR 6	TERASSA 7	CHOWRA 8	BUMPOKA 9
	A. DIVISION : CHLOROPHYTA									
	I) CLASS : CHLOROPHYCEAE									
	i) ORDER : ULOTRICHALES									
	a) FAMILY : ULOTRICHACEAE									
1	*Schizomeris leibleinii*						—			
	ii) ORDER : ULVALES									
	b) FAMILY : ULVACEAE									
2	*Enteromorpha compressa* (Linnaeus) Grev.	—	—	—	—	—	—	—	—	—
3	*Ulva fasciata* Delile.	—			—	—		—		—
4	*U. lactuca* Linn...	—						—		
5	*U. reticulata* Forsskal.	—		—		—				
6	*U. rigida* C. Ag.	—		—						
	iii) ORDER : CLADOPHORALES									
	c) FAMILY : CLADOPHORACEAE									
7	*Chaetomorpha antennina* (Bory) Kuetz	—			—	—	—			—
8	*Cladophora fascicularis* (Martens) Kuetz	—								
9	*C. utriculosa*					—				
	d)FAMILY : CAULERPACEAE									
10	*Caulerpa cuppressoides* (Vahl) Ag.		—	—		—			—	
11	*C. peltata* Lamour.	—			—	—			—	—
12	*C. racemosa* (Forsk.) Weber V. Bosse.				—				—	
13	*C. sertulariodes* (Gmelin) Howe.	—			—	—				
14	*C. taxifolia*	—								
	e) FAMILY : DASYCLADACEAE									
15	*Acetabularia calyculus* Quoit et Guimard.									
	f) FAMILY : CODIACEAE									
16	*Codium adherens* Anderson.	—	—		—	—				
17	*C. tomentosum* (Hudson) Stack house.	—								
18	*Halimeda macroloba* Decaisne.	—								—
19	*H. opuntia* f typica Barton.	—			—				—	—
20	*H. incrassata*	—		—	—		—	—	—	—
21	*H. peltata*	—					—	—	—	
22	*H. discoideae*				—		—			
	g) FAMILY : VALONIACEAE									
23	*Boergesenia forbesii* (Harv.) Feldm.	—					—		—	
24	*Valoniopsis pachynema* (Martens) Boerga.	—					—			
	B. DIVISION : PHAEOPHYTA									
	II) CLASS : PHAEOPHYCEAE									
	i) ORDER : ECTOCARPALES									
	a) FAMILY : ECTOCARPACEAE									
1	*Ectocarpus siliculosus*	—								

	ii) ORDER : D I C T Y O T A L E S									
	b) FAMILY : D I C T Y O T A C E A E									
2	*Dictyota bartayresiana* Lamour.	–								
3	*Dictyota dichotoma* (Huds.)Lamour.	–	–	–		–				
4	*Padina gymnospora* (Kuetz.)Vickers.	–	–	–	–	–	–	–	–	–
5	*P. pavonica* (L.)Thivy ex Taylor.	–								
6	*P. tetrastomatica* Hauck.	–			–	–			–	–
	iii) ORDER : D I C T Y O S I P H O N A L E S									
	C) FAMILY : P U N C T A R I A C E A E									
7	*Colpomenia sinuosa* Derb. et. sol.	–				–				
8	*Hydroclathrus clathratus* C. Ag.									
	iv) ORDER : F U C A L E S									
	d) FAMILY : C Y S T O S E R I A C E A E									
9	*Hormophysa triquetra*		–							
	e) Family : S A R G A S S A C E A E									
10	*Sargassum illicifolium* (Turner) J. Ag.	–	–	–	–	–	–	–	–	–
11	*S. myriocystem* J. Ag.	–								
12	*S. tenerrium* J. Ag.	–								
13	*S. wightii Greville.*	–	–	–	–	–			–	–
14	*S. duplicatum*	–					–			
15	*Turbinaria conoides* Kuetz.	–	–	–	–	–	–	–		–
16	*T. ornata* J. Ag.	–	–	–	–	–		–	–	
17	*T. turbinata*	–	–	–		–		–	–	–
18	*T. dentata*	–					–		–	
19	*T. decurrence*	–					–			
	C. DIVISION : R H O D O P H Y T A									
	III) CLASS : R H O D O P H Y C E A E									
	SUBCLASS : F L O R I D E A E									
	i) ORDER : N E M A L I O N A L E S									
	a) FAMILY : C H A E T A N G I A C E A E									
1	*Galaxaura oblongata* Lamour.	–				–	–			
	ii) ORDER : G E L I D I A L E S									
	b) FAMILY : G E L I D I A C E A E									
2	*Gelidium pusillum* (Stack-house) Le Jolis.	–								
3	*G. rigidum*	–							–	
4	*G. Heteroplatos*	–							–	
	c) FAMILY : G E L I D I E L L A C E A E									
5	*Gelidiella acerosa* (Forssk.)Fieldman et Hamel.	–					–		–	–
	iii) ORDER : C R Y P T O N E M I A L E S									
	d) FAMILY : R H Y Z O P H Y L L I D A C E A E									
6	Chondrococcus hornemanii (Mert.) Schmitz.		–				–			
	e) FAMILY : C O R A L L I N A C E A E									
7	*Amphiroa anceps* (Lamk.) Decsne.	–	–	–			–		–	–
8	*A. fragillissima* (L.)Lamour.				–			–		
9	*A. rigida*				–				–	
10	*Jania rubens* (L.)Lamour.		–							
	f) FAMILY : G R A T E L O U P I A C E A E									
11	*Grateloupia filicina* (Wulf.)J. Ag.	–								
12	*G. lithophila Boergesen.*	–					–			

13	*Halymenia floresia* (Clem.)Ag.	–								
	iv) ORDER : G I G A R T I N A L E S									
	g) FAMILY : G R A C I L A R I A C E A E									
14	*Gelidiopsis variablis* (Greville) Schmitz.	–					–		–	
15	*Gracilaria corticata* J. Ag.	–	–				–		–	
16	*Gracilaria crassa* (Harvey)	–			–	–	–	–		
17	*G. edulis* (Gmelin)Silva.	–			–		–	–	–	–
18	*G. folifera* (Forssk.)Boergesen.	–			–	–	–			
19	*G. Indica.*						–			
	h) FAMILY : H Y P N E A C E A E									
20	*Hypnea musciformis* (Wulf.) Lamour.	–				–	–	–		–
21	*Hypnea valentiae*	–								
	i) FAMILY : G I G A R T I N A C E A E									
22	*Gigartina acicularis* (Wulf.) Lamour.						–			
23	*Chondrus crispus*						–		–	
	v) ORDER : N E M A L I O N A L E S									
	j) FAMILY : HELMINTHOCLADIACEAE									
24	*Liagora ceranoides*						–			
25	*L. albicans Lamouroux.*						–			
26	*L. erecta* Zeh.									
	vi) ORDER : R H O D Y M E N I A L E S									
	k) FAMILY : R O D Y M E N I A C E A E									
27	*Rhodimenia australis* Sonder.					–				
	l) FAMILY : C H A M P I A C E A E									
28	*Champia parvula* (C. Ag.) Harvey.	–				–				
	vii) ORDER : C E R A M I A L E S									
	m)FAMILY : C E R A M I A C E A E									
29	*Centroceros clavulatum* (C. Ag.)Mont.	–	–	–	–					
30	*Spyridia filamentosa* (wulf.) Harvey.	–				–				
31	*S. fusiformis Boergesen*	–							–	
	n)FAMILY : R H O D O M E L A C E A E									
32	*Acanthophora spicifera* (Vahl.) Boerges.	–					–	–	–	–
33	*Chondria armata* Var. plumaris Boergesen.	–		–		–				
34	*Ceramium avalona*	–								
35	*Laurencia obtusa* (Huds.) Lamour.			–						
36	*Laurencia papillosa* (Forssk.)Grev.	–		–	–	–	–		–	–

ANNEXURE II

SEAWEEDS AND ENVIRONMENTAL FACTORS RELATIONSHIP
(Multiple Regression Analysis)

NOTE 1

DEPENDENT VARIABLES

Equation 1
Dependent Variable : OA or Y1 = OTHER ALGAE
Equation 2
Dependent Variable : Al or Y2 = ALGINOPHYTES
Equation 3
Dependent Variable : Ag or Y3 = AGAROPHYTES
Equation 4
Dependent Variable : TOT or Y4 = SEAWEEDS IN TOTAL

NOTE 2

VARIABLES IN THE EQUATION

Intertidal parts (Tables Ia, IIa, IIIa, IVa and Va)	Subtidal Parts (Tables Ib, IIb, IIIb, IVb and Vb)
X1 = TIDE	X1 = TIDE
X2 = RAIN	X2 = DEPTH
X3 = RELATIVE HUMIDITY or RH	X3 = WAVE
X4 = WAVE	X4 = WATER TEPERATURE
X5 = WATER TEMPERATURE or TEM1	X5 = LIGHT
X6 = ATMOSPHERIC TEMPERATURE or TEM2	X6 = SALINITY
X7 = SALINITY or SAL	X7 = DISSOLVED OXYGEN
X8 = DISSOLVED OXYGEN	X8 = PHOSPHATE
X9 = PHOSPHATE or PO4	X9 = NITRATE
X10 = NITRATE or NO4	X10 = NITRITE
X11 = SILICATE or SO4	X11 = SILICATE